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SEEKING AND SECURING THE PEACE

THE fundamental war aims of France and Great Britain have been stated clearly by the Prime Minister as being "to redeem Europe from the perpetual and constantly recurring fear of German aggression, and to enable the people of Europe to preserve their independence and their liberties". Mr. Chamberlain's clear-cut phrasing expresses without ambiguity the spirit of determination with which the peoples of France and Great Britain have entered on the task which lies before them. It reflects with crystal clearness their resolve to restore to Europe conditions in which all its nations, without discrimination, may live side by side in the firm assurance that each will be free to develop to the full and at will in accordance with its traditions and culture under a settled order, of which the sanctity is recognized and respected as inviolable equally by all.

For the man of science and the student of the modes of development of human societies throughout the ages, this resolve of the people and their leaders is pregnant with hope for the future. In its grasp of realities it argues an appreciation of the rights and dignity of the individual, as well as of the integrity of national units, which while observing every consideration for the expression of that individuality, will not hesitate to demand that in its exercise each will contribute its appropriate share to the common stock—a contribution which will not only recognize the rights of other communities, but will also co-operate to relieve their necessities. For we may rest assured from our experience of the last war that, at the close of hostilities, innumerable social and economic problems will arise to demand with insistence the co-operation of each and everyone for their solution, under penalty for failure of the collapse of civilization. It is not in this war that there lurks the supreme danger for mankind—no war undertaken in the spirit of a crusade can fail to ennoble, though the individual perish—but in the peace which will follow. The elimination of an aggressor will not solve automatically the difficulties which in recent years have troubled the world and left it at odds with itself. The ending of this striving for dominance will do no more than prepare the way to the search for a remedy for these difficulties. It will make possible co-operative study in the light of an objective and scientifically detached view of the facts and the circumstances from which they have arisen.

In this way alone, and only in such conditions in international relations as it is our aim to establish, will it be possible to exercise a scientific control of future social and economic development, instead of the erratic play of economic forces damned by ill-judged and ill-conceived measures to bolster up a false and misguided conception of national prosperity, or even of national security. Though projected to stem the breakdown of the economic system, many such measures have only accentuated its weaknesses by wrecking the system of exchange and hampering distribution, so that valuable products of soil and sea have been destroyed as a glut, and whole populations have been on the verge of starvation when the earth brought forth in plenty. The Government of the United States, the richest country in the world in gold, the conventional medium of exchange which it could not use, has spent billions of dollars in an ineffective endeavour to save the sturdiest and most thrifty of its population from complete destitution and extinction. It is problems such as these in an intensity increased, it may be,

a hundredfold, and probably with many more, which will still await solution 'after the war'.

Those of us who are old enough to remember clearly the outbreak of the two major wars in which the British people have been engaged in the present century—the Boer War and the War of 1914–18—will contrast, not without some amazement, the difference in the expression of popular feeling with which we have entered upon this war—a difference far more impressive in its undemonstrative exhibition of a complete unity of direction in purpose than the ebullient enthusiasm of the cheering crowds of the early August of 1914. Nor has there been any attempt to revive such an outbreak of popular feeling through the incitement of a vague and general statement of aims, an ideal for which we are to fight. We are not even assured, as politicians assured us in 1914, that this is "a war to end war". If we are the poorer in slogans, we are the more direct in purpose.

Yet, as the correspondence now appearing in the daily Press can show, there are those who hold that this direction of purpose might gain in strength and intensity if our ultimate aims were clearly defined. Mr. H. G. Wells, for example, in his letter in *The Times* of September 26, while arguing that "more and more of us are beginning to realize that there can be no more peace or safety on earth without a profound reconstruction of the methods of human living", goes on to assume that the Western world is quite inevitably marching towards a world collectivism. He suggests that we should make a genuine attempt to realize "that phase of world-wide plenty and safety" through a federation of mankind by free and unfettered discussion, simple and sincere, of the various means for the attainment of that end.

In Mr. Wells's view, the failure of the League of Nations to become such a federation of mankind as he envisages, was due to the fact that it was "too conservative of existing things, half-hearted, diplomatic". Is not the truth exactly contrary? Its most effective work has been in scientific research, the discussion of scientific, social, and economic problems, and the application of the results to practical problems—witness the virtual extirpation of the drug traffic in some of its darkest areas, and the measures for the suppression of the traffic in women. Here the League was at its most conservative. Such problems as these, and international co-operation in matters affecting literature, art and science, had for long been the order of the day. The League extended the scope of this co-operation, regularized and systematized it, and provided the machinery and organization for its more effective operation. Here it functioned with a most gratifying and surprising success. On the other hand, it was where it was most novel in its methods that it failed. For in a world of unharmonized peoples, many of whom were passing, or had passed recently, through a reconstruction on the principle of national or racial self-determination, it asked in some measure for an abrogation of a sovereignty either lately won or saved from destruction at enormous cost.

While the student of the forms of civilized society may see that the process of growth in the formation of human communities has been one of constant reintegration in larger and larger social unities—from family or kin to tribe, from tribe to people, from people to nation, and from nation to empire—it may well be that, in the long run, the logical goal of this ordered evolutionary process is the largest integration of all, the federation of mankind. But the time for this is not yet. Not merely is too large a proportion of the world's populations still in a state of retarded development—the populations of India and China alone, of whom a preponderating number is an impoverished peasantry, account for between a third and a half of the world's numbers—but the idea of nationality is too deep-seated as an emotional spring of action to be eliminated by the logical completeness of a theory. Though the excessive and frequently pernicious growth of nationalist sentiment in recent years has proved a setback to social and economic development, nevertheless a strong national tradition may be made a great asset to advancement, as the history of the world has shown.

In the discussion of problems of world-wide import—and all problems of a serious character nowadays tend to be world-wide in their application—in this discussion then, which is inevitable, racial and national traditions and cultures will each contribute a different point of view and a different outlook, whereby discussion will be the more capable of producing ultimate harmony, rather than any attempt to form an organization in which that tradition is likely to suffer a sense of frustration all too soon. For whatever may be the form or the machinery, be it league or federation, through which the peoples of the world will seek the co-operation which is inevitable unless

the order of civilization is to crumble away, it is not discussion of general principles or machinery, in other words of the form of government and the means to secure it, which will save mankind from disaster, but the scientific study on a co-operative basis of the concrete problems which are vital to the well-being and the very existence of the unit from which the social aggregation is built up, whatever its form—the individual man, woman and child.

THE NATIONAL REGISTER

A NATIONAL REGISTER is, in essence, a continuous census. It is best regarded as a means of obtaining and recording that accurate knowledge of its human resources which the advance of science has made necessary to a civilized community. For more than a century past a periodic census has given us a record, at approximately ten-year intervals, of the numbers and distribution of the population in Great Britain, together with varying amounts of information about its composition as to sex, age, occupations, and so on. These records have become fuller during that time; and there has been pressure to make them also more frequent. A quinquennial census has been authorized, though not carried out. Now, under the stress of war, we have begun the transition from a periodic to a continuous record. Of course, it is not possible to publish continuously; but it should be possible to issue quarterly returns, akin to those now submitted by the registrars-general in respect to births, deaths, and marriages.

The information collected for this first edition of a British National Register is similar to, though less extensive than, that for recent censuses. It is limited to the name, sex, age, condition as to marriage, and occupation of every individual, with an additional column for members of the defence services. The plans for it were made during peace but are being carried out in a country at war, which is probably the reason for the extreme reduction of the form to be filled in by each householder. The most striking omissions are the absence of questions as to nationality, birthplace, workplace, or usual residence for those away from home. The first of these may perhaps be adequately replaced by the register of aliens kept by the police; the others are less urgent at present. But all these, and more, will be needed for a permanent national register.

The new feature which distinguishes this registration from all previous censuses is the provision for keeping it up to date. This takes the form of a legal obligation placed on all persons to notify every change of residence to the National Registration Officer of the district into which they move. Soon this must be extended to notification of all changes that affect the Register, and are not otherwise recorded, such as a change of occupation. The records of all these changes will make it possible to obtain information of increase or decrease of population in every local government district at frequent intervals. Everyone concerned with the administration of local government, or of education, has often felt the need for such information, which will now become available in respect of all the people. It has hitherto been available only in respect of certain groups, such as those on the live registers of the employment exchanges. It is urgently needed by all authorities responsible for public health. For all such services, and for local transport and retail distribution, a National Register will make possible greater efficiency, providing that it is well maintained.

The last full census was taken in 1931. It is, therefore, out of date for many purposes. The need for a prompt stocktaking of all our manpower is now urgent; and the experience of the War of 1914–18 shows that some such register can be invaluable in respect to both military and industrial organization for war and to the maintenance of the national life. By its regimentation and conscription of men and women, the German Reich has already got some corresponding record of its human resources. Not enough is known here about the system used to allow useful comparisons with this British register.

It is unfortunate that the Register was not compiled months ago, before the outbreak of war made the task at once more urgent and more difficult. The evacuation of children and women from large towns, and the parallel removal of many other people will make the early months of the war a time of special difficulty in keeping in touch with the abnormal number of changes of residence. On the other hand, the fact that the Register is to

form the basis for the lists of those entitled to food ration cards provides a strong incentive to prompt notification. Even so, the organization for the maintenance of the Register will be very severely tested in the next few months.

This registration is accompanied by the introduction of the personal identity card, which has long been a familiar thing in many European countries, where its value has been well proved. Like the Register, this first identity card is extremely simplified: in fact it is scarcely more than a reference to the register by name and number. But both should become permanent features of our national life; and both will inevitably become more comprehensive. The value of the card is obvious. In normal times, cases of difficulty in the identification of persons suffering from loss of memory, or victims of street accidents, are sufficiently frequent to stress the need for such a document. Only the law-breaker has a real, if not a socially valid, reason for objecting to it. It is interesting to note that it does not bear the name of the country, thus following the tradition of British postage stamps.

The National Register and the identity card are essential to the scientific organization of a civilized community, and should have been introduced years ago. The State which does not know its human resources accurately cannot organize them well; nor can it measure with sufficient accuracy its liabilities to its dependent members and its children. The rapidly increasing complexity of modern life, and the resultant increase in the number, the importance, and the intricacy of the functions of government, national and local, and of other social organizations, make it more and more necessary that their working shall be based on a full and accurate knowledge of our human resources and liabilities. For defence against external enemies, against disease, and against internal disorder, for the supply of satisfactory nutrition to all the population, in fact for all the many needs of social life for which we, as social beings, are dependent on the society of which we are units, it is necessary to have such knowledge as a national register can best provide. Each one of us is, willy-nilly, in some degree his brother's keeper and is affected by that brother's well-being or misfortune, and for the fulfilment of the social duties implied in this relation we need this knowledge.

Of course this does not mean that the mere existence of a national register, however complete and well kept it may be, will ensure social efficiency. Nor can it determine any policy. It may be a basis for the development and application of policies of very different types and aims. It is only a tool, a very valuable tool, for the organization of life in a civilized country. How, and for what purposes, such a tool may or will be used is a matter of national policy that will be determined in the same way as other such policies are decided in Great Britain.

As an example of the matters on which precise information can be obtained from the Register as it is now, we may note the composition of the population, nationally and locally, by age and sex groups. It will be possible to know promptly if, and how far, internal movements such as the so-called 'drift to the south' have left some areas with an unduly low proportion of adolescents and young adults, and a correspondingly high proportion of either or both children and old people, and given to the areas of immigration a badly balanced population of reverse type. Many other examples of such possibilities could be given; but this one is enough to emphasize the value of the Register in enabling us to have accurate information of such social facts in place of uncertain estimates, which have hitherto been checked only by the periodic census.

This is the first attempt at compiling a national register in Great Britain; and, although it has been carefully planned, it is experimental. There can be no doubt that experience of its working will give rise to many suggestions for improvements and extensions intended to make it more useful. After the war, at least one census will be needed as a check on its accuracy, and to strengthen the continuity of our national records by an overlap between the periodic censuses and the continuous register. There will also be changes in the identity card and the record on it. Some day the official mind may grasp the fact that it would be a convenience to the public if such things as this card, driving licences, bank notes, postage stamp books, and other articles to be carried in a man's pocket or a lady's handbag, were made of standard uniform sizes.

The most valuable of all our national resources is the human material. The National Register can help to provide a more scientific basis for attempts to improve its quality, by nutrition and training, to control its numbers, and to make better use of it in the development of the good life for all members of our society.

THE MARIHUANA PROBLEM

Marihuana, America's New Drug Problem
A Sociologic Question with its Basic Explanation dependent on Biologic and Medical Principles. By Prof. Robert P. Walton. Pp. ix+223+12 plates. (Philadelphia and London: J. B. Lippincott Co., 1938.) 12*s*. 6*d*. net.

THE hop plant (*Humulus lupulus*) and hemp (*Cannabis sativa*) are close botanical relatives and each secretes a physiologically active resin. The hop resin is, of course, important in Europe in the manufacture of beer, but hemp resin has found little application, the plant being normally grown only for fibre production. A different state of affairs exists in Africa, the Near East and India, where the resinous exudate of the hemp plant has been widely used (or abused) from remote times for its narcotic properties, under a variety of names according to mode of preparation, the best known of which is perhaps hashish. The virtual absence of hashish addiction in Europe can scarcely be attributed to difficulty of access, since hemp is readily cultivated, particularly in the Mediterranean area, and it has been frequently assumed that temperamental differences between Europeans and Orientals make the euphoric action of hashish less attractive to the former. A similar explanation has been advanced to explain the preference of the Chinese for the languorous dreams of opium rather than the wild ecstasy of hashish.

Viewed in this light, the establishment of the hashish habit in Central America, where hemp, under the name of marihuana, is smoked usually in the form of cigarettes, is perhaps not surprising, nor is the fact that marihuana smoking penetrated to some extent from Mexico into the extreme south of the United States. Astonishing, however, is the enormous increase in the vice which has taken place throughout the United States during the last ten years. There it has assumed almost epidemic proportions and has become a national problem. A particularly dangerous feature of the American situation to-day is the spread of the habit among school children and adolescents, and it is this feature which has made marihuana a subject of moment not only to the Bureau of Narcotics but also to every class of social worker. The increasing attention given to this problem has, of course, stimulated the interest of medical and scientific investigators, since it is clear that a thorough knowledge of the drug in all its aspects is of primary importance in combating the menace of its use.

The literature on the subject of hashish is vast and so heterogeneous in character that it is no simple matter to obtain from it a clear picture of any feature of the subject. Medical and scientific workers will therefore welcome this admirable monograph by Prof. Walton, which provides a survey of our present knowledge of hashish. The lay reader will doubtless find much of interest and value in the chapters dealing with the history and distribution of the vice and its present status in America. As this section, however, comprises but 39 pages of reading matter out of a total of 195, it does not, in the reviewer's opinion, justify the advertising matter on the dust cover of the volume; this at first sight suggests a popular treatment of the marihuana habit rather than a monograph dealing with hemp drugs from a scientific point of view. The section of the book dealing with descriptions of the hashish experience is fairly extensive, but while it is true that the layman might be interested in at least the more colourful literary descriptions of Ludlow and Gautier, it is difficult to see how he would benefit in any way from them.

Of particular value to the professional reader are the chapters devoted to acute and chronic effects of hashish, in which the author has analysed the recorded descriptions of its effect and has carefully classified them; his findings should remove many common misconceptions. Save in extreme cases, deprivation of the drug appears to cause no serious physical symptoms in marihuana addicts, and the tendency to chronic addiction is much less than that observed with the so-called 'white' drugs (cocaine, etc.). These facts, together with the relatively low degree of physical deterioration associated with the use of hemp drugs have, of course, been known for a considerable time, and the Indian Hemp Drug Commission reported that the hemp drugs were considered by many in India to be less harmful than alcohol. Prof. Walton, however, rightly stresses that the most serious aspect of the problem in America is the extent to which the vice promotes juvenile delinquency, serves as an introduction to more dangerous drugs, and increases the use of extreme violence by criminals.

The two chapters dealing with the pharmacology and chemistry of hashish cover practically all the published work on the subject, and there are

many references to the original literature. The bibliography is good and the appendix on the nomenclature of the various hemp preparations used throughout the world is most valuable. One feels with the author that although therapeutic applications of Cannabis are at present negligible, the drug is well worth further consideration, since its extraordinary physiological action suggests that a marked increase in therapeutic use may follow the isolation and identification of the active principles.

A. R. TODD.

METALS AND THEIR ALLOYS

Metals and Their Alloys
By Sir Harold Carpenter and Dr. J. M. Robertson. Vol. 1. Pp. xxii+824. Vol. 2. Pp. xii+825–1486. (London, New York and Toronto: Oxford University Press, 1939.) 105*s*. net.

THE publication of the present work in two volumes by Sir Harold Carpenter and Dr. J. M. Robertson is an event which merits not only especial mention but also especial consideration. For, as a result of the actual development of our knowledge, works of this kind, if not exceptional or unique, are becoming increasingly rare.

The wide range of subjects under consideration in this work—which is concerned with metals and their alloys, with their constitution, their structure, their treatment from both the thermal and mechanical aspects, and with their properties and uses—together with the monumental qualities of the book, which contains 1,472 pages and the spirit, both theoretical and practical, in which it is conceived, might tempt one to regard it as a treatise. But in actual fact it is no treatise, neither in conception, inspiration, execution or purpose.

A treatise proper may be defined as an exposition, as complete as possible, of the sum total of knowledge and experience concerning the subject under consideration—in this case, the science of metals and their alloys together with practical applications. Such a work is designed to include within its scope every publication on the subject, regardless of relative value; and to present them all as being on the same level. But although the number of publications mentioned in the present work is very large (more than six hundred) the authors have made their selection; for, as Sir Harold Carpenter says in his preface, if the development of present ideas and theories were to be traced and all opinions and criticisms represented, this number would have to be doubled. Thus it is the personal opinion of the authors which is expounded in these two volumes rather than the sum total of published opinion.

In the same way, a critical selection of published works which the authors consider to be the most useful for the purpose in view, has been included.

Furthermore, in view of the accelerated pace of research and the consequent mass of published work, the material labour involved in the publication of a treatise proper would involve the collaboration of a large number of different authors who would divide among themselves the labour of analysis and exposition of the published material. In this way, a treatise proper loses in unity of thought and conception what it gains in the extent and quantity of accumulated documentary material. A treatise is intended to be included in a reference library; but not to be read and meditated over as a whole. It is a tool or instrument, rather than a work of instruction; and seldom possesses either educational or critical value.

On the other hand, the work under review, which has been completed in its entirety by two authors in close collaboration, manages to preserve a remarkable unity of thought and opinion. To me it appears as an achievement of unique educational value, whether to a student in the completion of his studies, to an engineer desiring to keep in touch with the latest advances in metallurgical science, or to a specialist anxious to compare and debate his opinions with those of a master of the subject.

This book might well be included in an academic course; and, as a matter of actual fact, one of the authors, Sir Harold Carpenter himself, occupies the principal chair in metallurgy in England, apart from which he has presided over and directed the investigations of three great technical institutions concerned with metals; namely, the Iron and Steel Institute, the Institute of Metals and the Institution of Mining and Metallurgy. All this is a proof of his exceptional authority and is also largely responsible for the perfection of this book as a whole and for the admirable sequence and co-ordination of the material contained in it. Actually, at the present time, the structure of metals considered from every aspect constitutes

the essential foundations of our knowledge when it is combined, on one hand with the chemical composition of the product furnished by the metallurgist and, on the other, with the mechanical and heat treatment effected by the transformer; and finally, with those properties which constitute the very basis of practical usage and application.

At the same time, the work—very justifiably—includes in the preliminary chapters a thorough and careful study of the constitution of metals and their alloys, together with their relations to deformations. This is followed by an examination of properties and treatments. These comprehensive chapters concerned with instruction in general metallography constitute the first volume of the work (Chapters i to x)—a volume which thus expresses its individuality and unity.

Incidentally, the remarkable order in the arrangement of the book as a whole is equally carried out in the detailed presentation of the various chapters; and particularly in those dealing with the deformation of metals, which show clearly, on one hand, the interdependence of the three variables—time, temperature and deformation—and, on the other, the triple aspect of the mechanical problem which they condition: namely, a deformation which is very limited in practice, an important deformation without rupture in cases of mechanical transformation, and a deformation forced to the point of rupture in mechanical experiment.

The principles enunciated in the first volume find their application in the second, which is concerned with those metals and alloys, both ferrous and non-ferrous, which are of the greatest importance to industry. These chapters also are very well balanced.

From the point of view of the instructive value of the work, it is perhaps a pity that the authors found it necessary, in order not to be involved in a long chain of developments, to suppress the historical section dealing with the laborious acquisition of our knowledge of metals and their alloys. An exposition of the kind has a distinct educative value inasmuch as it helps the student and others to realize that this knowledge is not the product of to-day, but has been slowly and painfully amassed over a long period of time. Furthermore, it helps to show him that many of the most modern ideas on the subject were divined or predicted by men of exceptional perspicacity and foresight—men such as Sorby, Tschernoff and Osmond, whose names should live for ever in the minds of successive generations of metallurgists. It is for this reason that the present authors, in their just appreciation and recognition of all those who have in any way contributed to the building of this scientific edifice, have dedicated their book to them.

In the planning and development of the various chapters of the book the pedagogic qualities of the authors have been fully demonstrated. But they appear also in another capacity, as experimenters who have themselves made contributions of the first importance to the subject. Neither the compilers of treatises nor those who devote themselves to the task of imparting knowledge are necessarily at the same time research workers or experimenters. Indeed, the combination is a very rare one. For the builder and architect can quite well work with materials furnished and delivered by others. But Sir Harold Carpenter and Dr. Robertson are both world-famous for their work on metals, and this fact lends an especial interest to the chapters of the book in which they record the development of their own experimental work.

To give one example only. In Chapter xi, where the transformation of the iron-carbon alloys is described, the account is based, for the most part, on three papers of fundamental importance, by Sir Harold Carpenter and Dr. Robertson, which were read at the Iron and Steel Institute between 1931 and 1933 (The Formation of Pearlite from Austenite; The Austenite – Pearlite Inversion; Structural Changes in Hypo-eutectoid Steel on Heating). These papers had been preceded in 1931 by a work of Dr. Robertson's on "The Effect of the Rate of Cooling on the Structure and Constitution of Steel" published by the Mines Department (Publication No. 59 of the Safety in Mines Research Board). For this reason, unfortunately, the work is relatively little known, especially to French readers; and this is all the more regrettable in view of the fact that the work of the French school is both emphasized and appreciated in the paper. It is thus very welcome to find in one of these chapters a description of the whole of the original work done by the authors themselves, illustrated by their exceedingly remarkable photomicrographs.

Thus, two characteristic aspects of the authors' activities—instruction and scientific research—are combined harmoniously to lend a particularly individual quality to this work, namely, the quality of a didactical exposition of the whole of our metallographical knowledge as conceived by them as a result of their own researches and of the study of other published investigations.

The work as a whole constitutes a most valuable synthesis to which, in this branch of science, it would be difficult to find a parallel. A work such as the present one represents an expenditure of effort undertaken in a spirit of enthusiasm. It

is a task accomplished as a result of years spent in the calm of scientific meditation and reflection. All this confers upon it an individual and lasting value; and the appearance of the two volumes, the illustrations, etc., are excellent and worthy of the contents.

This is not a book to be relegated to library shelves, but should have its place on the desk or work-table. It is not a mere distributor of information, but a source of creative ideas and researches and therefore rich in consequences.

ALBERT M. PORTEVIN.

INTRODUCTORY FORESTRY

(1) An Introduction to American Forestry
By Prof. Shirley Walter Allen. (American Forestry Series.) Pp. viii + 402. (New York and London: McGraw-Hill Book Co., Inc., 1938.) 21*s*.

(2) The Nation's Forests
By William Atherton Du Puy. Pp. ix + 264. (New York: The Macmillan Company, 1938.) 13*s*. net.

(3) An Outline of Forestry
By Thomas Thomson and M. R. K. Jerram. Pp. viii + 208. (London: Thomas Murby and Co., 1938.) 7*s*. 6*d*. net.

(1) THIS is the first volume of an "American Forestry Series" which will include other volumes on "The Theory and Practice of Silviculture", "Forest Pathology", "Identification of the Timbers of the United States", "Forest Mensuration", "Forest Insects", "Textbook of Dendrology and Management of American Forests".

The present volume by Shirley Walter Allen, professor of forestry, University of Michigan, expresses its object in the words in the preface, "Forestry is in need of a wider circle of acquaintances". Since there has been a Forest Service in the United States of America for several decades, this displays the difficulties of implanting in the public, as we know in Great Britain, a knowledge and sound appreciation of the value of forests to a country. The author has accordingly aimed, not so much at the instruction of forestry students who intend taking up forestry as their professional work (though as an introduction it serves that purpose) but rather at instructing a reading public.

It may be admitted that Frof. Allen's aim is admirably fulfilled, if we omit the factor of its length. For example, since the "Series" is to include volumes on protection, the sixty-five pages devoted to the subject might have been curtailed.

The plan of the book is indicated by the chapters, as follows: man and the forest, building the country with forests, where our forests are and what they produce, what a forest is, forestry that starts with a forest (a chapter which may well be commended to those responsible for the great existing forest capital in the Colonies under British administration), forestry that starts with bare ground, defending the forests from (1) fire, (2) insects, etc., (3) fungus, pests and the elements, measuring and harvesting, and finally, several chapters on forest policy generally. An appendix is devoted to general statistics.

(2) An even more popularly written book than Allen's "Introduction" is Mr. W. A. Du Puy's "The Nation's Forests", which has an introduction by that eminent forester, F. A. Silcox, chief of the United States Forest Service.

In the introduction, Mr. Silcox writes: "For the most part, those of us who handle forest problems are technical men. We are very close to our tasks. It seems difficult for us to tell, simply but graphically, about the vast public properties entrusted to our care; about what those properties are, how they are used, how—directly and indirectly—they affect the average citizen; how they make more jobs; how they add to the security and stability of families and communities, and increase the permanent wealth of a nation". To some extent Mr. Silcox is correct in his complaint that the forest officer is curiously pen-tied when he wishes to transmit his thoughts on his work and on Nature as he sees it to the public; and commonly the layman does not possess sufficient technical knowledge to paint a correct picture. In the book in question, written for America and Americans, Mr. Du Puy shows that he possesses both knowledge and facility to translate forestry problems into easy, even fascinating, language based on personal investigations.

The author commences by pointing out that each American citizen possesses an 'estate' of one and a third acres—his share of the national forests—and this is supported by the striking photograph of a forest fire, facing p. 124. The photographs form an educative feature of the book. This latter is divided into fourteen chapters, entitled: everyman's forest, when the lumberman came, Nature heals her wounds, which trees to cut, planting forests and sustained yield, erosion control, fire protection and recreation, wild animals, range management and wilderness areas, of which all are well written. Finally, the author deals with products of wood, and State and private forestry.

(3) This text-book is written by two members of the staff of the Bangor Forestry School at the

University College of North Wales—Messrs. T. Thomson and M. R. K. Jerram. The aims of the book are not so clear cut as those of the two American books already discussed. The authors suffer from having attempted too much. They state that their "main object is to provide for students on their initial approach to the subject an explanatory outline of the kind of knowledge they will have to acquire; it is hoped that it may prove useful to others who are interested in the subject". If we consider Chapter iii, on the practice of sylviculture, which forms one fourth of the book, the material dealt with is far beyond the ordinary reader and comes under the definition 'technical'.

In two hundred pages the authors have attempted in reality to cover the whole subject of forestry, as shown by their own table on p. 6, which exhibits their four main divisions: forest policy; forest bionomics, subdivided into the foundations of sylviculture, the practice of sylviculture, and forest protection; forest economics, subdivided into forest valuation and finance, and forest utilization; forest management, subdivided into general considerations, the regulation of the yield and the preparation of a forest working plan.

It is somewhat difficult to say to whom the book will appeal. Most trained foresters nowadays hold the opinion that the above branches of forestry require to be kept apart and considered separately in text-books to be used by the student training for the forestry profession—as in fact is shown in "American Forestry Series" alluded to above. For example, Chapter x is entitled "The Preparation of a Forest Working Plan". This important subject is discussed in some three and a half pages. For the ordinary reader possessing some knowledge of forestry, the book may be commended, as it contains much useful material.

SOME EARLY GANOID FISHES

The Triassic Fishes of Besano, Lombardy

By James Brough. Pp. ix+117+7 plates. (London: British Museum (Natural History), 1939). 20*s*.

DURING the Triassic period the ganoid fishes with a gristly skeleton, belonging to the same grade as the existing sturgeons, were gradually replaced by ganoid fishes with a bony skeleton like the surviving Amia and Lepidosteus of North American fresh waters. Links between the two grades have already been recognized among Triassic fishes, and there can be no doubt that the one evolved from the other. The transition, however, evidently took place in the sea, and it has hitherto been studied chiefly when it was beginning (as in the Lower Trias of Spitsbergen, East Greenland, and Madagascar) and when it was almost completed (as in the Upper Trias and Rhætic of Italy and Austria). The ganoids of the Middle Trias—those of the critical period—are still well known only by freshwater forms from Australia and South Africa; and it must be noted that from early geological times onwards fresh waters have always been retreats for life which is no longer in the forefront of progress.

A large collection of marine fishes from the Middle Trias of Besano, Lombardy, recently obtained by the British Museum, is therefore of great interest, and it is now made available for science by a descriptive catalogue which has been prepared by Mr. James Brough. There is a varied series of new forms intermediate between the older and the later ganoid grades, and they are well illustrated by numerous outline sketches, restorations, and beautifully clear untouched photographs.

The essential changes in the bones of the cheek and in the median fins are especially traceable, and there seem to be all possible gradations. In fact, as Mr. Brough remarks, the ganoids of the later or 'Holostean' grade appear to have originated in several parallel lineages from the earlier or 'Chondrostean' grade. At first the preoperculum is a broad plate extending over the cheek above the long maxilla; it then gradually shrinks backwards until it forms merely the front rim of the gill cover, while the maxilla is reduced behind and is left comparatively free. At first the tail is completely heterocercal, but the upper lobe soon becomes extremely reduced or even disappears; and the dorsal and anal fins are made more efficient by the exact correlation of the dermal rays with their endoskeletal supports.

There are so many variants in this evolution that Mr. Brough classifies the new Middle Triassic fishes in seven families, and he suggests that they should be separated both from the Chondrostei and from the Holostei in an order Sub-Holostei. He also describes in detail two of the earliest holosteans of the family Eugnathidæ, and discusses the relationship of the Triassic bony fishes to those of later date. Mr. Brough's volume is much more than a museum catalogue, and he is to be congratulated on having formulated problems of wide biological and geological interest.

A. Smith Woodward.

SCIENTIFIC RESEARCH AND AGRICULTURE*

BY SIR THOMAS MIDDLETON, K.C.I.E., K.B.E., C.B., F.R.S.

WHEN, in 1912, Section M held its first meeting, my presidential address was upon the early improvers of husbandry, and I referred especially to the assistance given to agriculture through the societies and associations formed by them for promoting experiments and discussion. Section M was the latest addition to associations of the kind, and we who were then present looked forward with expectation to the benefit agricultural science would get from the formation of the new section. In spite of the calamity of the War of 1914–18 and the unrest in the world which has since developed, I feel sure that, in returning to Dundee where that first meeting was held twenty-seven years ago, all will agree that the hopes then formed have been more than fulfilled by the progress of Section M.

My purpose in selecting the motto "Practice with Science" is not to use it as an occasion for a review, but so that I may refer to matters affecting the present circumstances of both partners in the motto. The existence of Section M is in itself a proof of the large amount of scientific work now being carried out on behalf of agriculture, and also of the interest which the scientific public take in the subject. Although it has many shortcomings, as the workers concerned will be the first to admit, it may be claimed for agricultural science that it has prospered and is prospering; in contrast, everywhere there is evidence of the difficulties of agricultural practice.

With subsidies, price-insurance and other measures of the kind for assisting agriculture which at present occupy so much of the farmer's thoughts, the majority of scientific workers have no direct concern. The remedies for agriculture's handicaps which they have to offer depend on research, and fortunately research is a remedy so widely approved that, when it does arouse criticism, the complaint usually is that too little use is made of it and that the financial resources provided are too meagre.

For criticism of the kind there is, no doubt, justification; but in the past thirty years, scientific research in agriculture has made great progress in Great Britain, and the prospects for further progress are now better than they ever have been. The subjects under investigation at our research institutes and university departments of agriculture are so numerous that the time at my disposal would not permit me to comment on them in any adequate way. My remarks on the scientific workers' programmes must necessarily be of a very restricted kind.

As for meagre financial resources, no one can be more conscious of the needs and demands of the scientific worker than I am. During long years in Whitehall, I have many times reflected that the doctrines of Malthus, confounded though they may be by twentieth-century birth statistics, are peculiarly applicable to agricultural science; the pressure of its annual recruits on the means of subsistence has given me many an anxious hour. Yet when I look back to the first years of the century, when Hall, Russell, Percival and Theobald were breaking new ground at Wye, when Wood and Biffen were making the reputation of the Cambridge School of Agriculture, when Somerville had already shown how pasture improvement may be effected and measured, it is not the meagreness, but the growth of the resources now available to the agricultural worker that impress me. For I recall that, in the first report to be written by me in Whitehall Place, I had to point out that for the purpose of experimental work and research the State had granted no more than £380, whereas in the present year the Development Fund, which Mr. Lloyd George provided for us in 1909, is assisting the scientific worker in agriculture, and through him the British public, to the extent of some £500,000; and the Development Fund, although much the most important, is not the only source of funds available.

It is questionable if the general public realizes how largely the programmes of the agricultural investigator are framed in the interests of the nation as a whole. Indeed, if these programmes were framed solely for the farmer's benefit, some who have read my doleful account of the difficulties caused to the unhappy farmer by surfeited markets, may suppose that my remedy would be transference of the millstone of surplus from the shoulders of the producer to the neck of the scientific worker! But although fully conscious of the large increase in world production recently brought about as a result of the activities of plant breeders, chemists, pathologists and others, I trust you will not think my logic faulty if I disclaim any such idea.

* From Part II of the presidential address entitled "Practice with Science", Section M (Agriculture) of the British Association, delivered at Dundee on August 31.

Take, for example, the benefits that both agriculture and nutrition would derive from discoveries that would improve the health of farm livestock. By raising the standard of health in domestic animals we would meet some of the most insistent demands of nutrition experts. It is generally agreed that nothing would do more to reduce the number of C3's among us than an increase in the consumption of milk and eggs; it is generally claimed, too, that to secure increased consumption, prices must be less than they now are, and I believe it will be held by those who have studied costs of production that the possibility of lowering prices depends first and foremost on improving the health of the cow and the hen. So long as the wastage in dairy herds and poultry flocks remains at the present level, it is difficult to see how the cost of milk and eggs could be much reduced. To a less extent, perhaps, but still to a substantial degree, the cost of other animal products is increased by the ravages of disease on our flocks and herds.

It was the extent of these losses to the stock owner, and their effect on the food supply of the public, that led the Agricultural Research Council, soon after it was established in 1931 and had surveyed the tasks confronting it, to decide that its main effort in the immediate future should aim at effecting an improvement in the health of farm animals.

With this object in view the Council formed technical committees which brought together for joint study those already engaged in the investigation of a number of diseases of special importance. It made grants for assisting research in numerous cases where additional funds were necessary. It employed trained surveyors to visit stock-raising districts in which diseases, especially those of an obscure kind, were prevalent, and in this way collected much fresh information on the incidence of disease. Experience gained in work of the kind pointed to the need for a central field station at which it would be possible to carry out investigations on selected diseases on a large scale and under farm conditions. For this purpose the Council has acquired an estate of about 1,500 acres, and this is being provided with laboratories, houses for the breeding of laboratory animals and isolated cattle sheds for accommodating animals under investigation.

The work of the Council on animals is paralleled by the assistance it provides for investigational work on farm crops. Committees of specialist workers have been set up, for example, on virus diseases, on plant diseases due to helminth attack and on insecticides and fungicides. One very active committee has been that on the Preservation of Grass and other Fodder Crops. Most of the special grants made by the Council for work on crops are in aid of pathological investigations. Until 1911 very little attention was given to crop diseases in Great Britain, but when the Development Act provided funds, entomologists and mycologists were added to the staffs of most agricultural institutions and, as research workers or advisory officers, they have since given much-needed help to agriculture and horticulture; thus the increase in fruit growing and other forms of horticulture that has taken place in recent years has been stimulated by the researches of plant pathologists and, as in the case of animal products, the nutritional demands of the public are being successfully met because of the invaluable aid which the scientific worker is able to give to the producer. Some of the best examples of "Practice with Science" that the country can show to-day may be found in the orchards of Kent and other apple-growing counties.

So far I have referred to matters that engage the attention of the scientific worker, while agriculture follows what has been called 'its natural lines'; but unhappily for us, our peaceful art must face the problems raised by war, and although opinions have been expressed, and expressed freely on the subject in recent months, it cannot be said that there is any agreement on the role that agriculture either should, or could, be expected to fill in the event of war. Recent discussions, and my own experience in attempting to increase home produce during the War of 1914–18, lead me, therefore, now to refer to the scientific workers' programme in connexion with home food production.

In recent discussions on this subject, advocates of storage, of increased shipping for transport and of increased tillage for home production have all been heard, but too frequently as advocates of rival methods of providing supplies in war. It cannot be stated too strongly that these methods are in no sense rivals. All the aid that each can give would be wanted in a war of long duration. In the early stages of a war, stores would be of especial value, throughout the period of hostilities all the tonnage which could be made available for the carriage of human and animal foodstuffs would certainly be wanted, and in the later stages of a long war reliance might have to be placed largely on home supplies.

It may be accepted, I think, that in any emergency, while every effort would be made to maintain our normal diet, chief anxiety would be caused by the position of energy-supplying foods, in practice our breadstuffs. It was generally recognized during 1914–18 that the comparative absence of food difficulties then experienced was due to the circumstance that breadstuffs were not rationed.

In the pre-war years 1909–13 Great Britain was producing about 35 per cent of its energy requirements; in 1918 the food production campaign succeeded in raising the home supply to about 42 per cent. Entering the war with home supplies that would have maintained us for 125 days, we produced in 1918 the equivalent of 155 days' normal needs. Because of lack of labour, machinery and implements the difficulties we faced were extreme. With the number of tractors now available, grassland could be broken up rapidly; but it is one thing to break up grassland and quite another thing to farm it properly, and it is the farming, rather than the breaking up, that calls for careful preparatory work.

But why break up grassland? That was the question asked in 1915 and 1916; it caused much controversy and will do so again.

The answer is that, of human food of the kind which we should chiefly want in war, other crops produce much more than grass. In "Food Production in War" I have given many figures in support of this opinion which I need not cite here: one general statement will suffice. In the years 1909–13 the soils of the United Kingdom maintained a population of about 15½ millions. I estimated that less than one-third of this total had been maintained by our 34 million acres of cultivated grassland (that is, had been provided with the million Calories per person per annum necessary), and that more than two-thirds had been maintained by our 13 million acres under crops other than grass. Per 100 acres of land, 12 and 80 persons respectively had been provided for. These figures, though they relate to the energy value of foods only and not to other things which are essential in our diet, give a fairly correct idea of the relative importance of grass and other crops in providing war rations. The chief reason for the very low production shown by grass is that a large percentage of our grassland is of poor quality and is grazed by store cattle and sheep. For the average pasture grazed by dairy cows my figure was 41 persons maintained per 100 acres; well-managed grass carrying good cows might indeed provide the energy needs of 75–80 persons per 100 acres.

Our present systems of husbandry took form long before the aeroplane had to be reckoned with and they may be regarded as suitable for conditions that until recently existed, but I cannot agree that, as Europe now is, we should remain satisfied with methods of farming that, in war, would leave us dependent for some 65 per cent of our food supply on imports. My personal view is that, for defence reasons, we must change to a more flexible method of farming than that which is now commonly followed, that we should adopt a system which under peace conditions would provide from 35 to 40 per cent of our requirements and in an emergency would enable us rapidly to increase food production to a figure providing about half our annual needs. The change which, for defence reasons, I now advocate is that for which my predecessor argued at Cambridge on grounds of good farming, namely, a change over from permanent to temporary grass.

Sir George Stapledon advocated ley farming on an extensive scale. The adoption of this system would in his view improve the output of nearly all English cultivated grassland. For the purpose I suggest above, it would not be necessary to replace more than from four to five million acres of permanent grass by temporary leys. If, say, 4½ million acres were thus converted, Great Britain would then have 16½ million acres under arable cultivation as it had fifty years ago. About 40 per cent of the cultivated area would still remain under permanent grass, so that, in selecting the area for conversion into temporary leys, a wide choice would be available.

The substitution of temporary for permanent grass need not, in itself, call for substantial changes in the character of the land's output. The grassland would, as Sir George Stapledon stated, carry more stock, and if stock were paying better than crops the main change in output under peace conditions would be an increase in livestock products. From the point of view of war farming the advantages of temporary leys are obvious. The use of the plough and of other implements would be familiar to farmers cultivating temporary leys, but in many cases would be quite unfamiliar to those occupying only permanent grass. Tillage implements would be available on the farms on which they would be required in an emergency and the quality of the land itself for tillage purposes would be well known; thus, in an emergency, arrangements for corn growing could quickly and easily be made.

In spite of the advantages to both the country and the farmer which can be claimed for ley farming, it must be recognized that in England there are circumstances which strongly tend to check the spread of the system. Permanent grass growing is the well-established custom of the country; the change over from tillage to grass farming saved many from bankruptcy at the end of the nineteenth century, and since that time grazing has, on the whole, been a safer business than agriculture. Again, short of capital as farmers are, it would take a good deal of courage to expend £3 to £7 per acre in forming a temporary ley, even if arithmetic proved that a return of 10 to 20 per cent on the outlay may be expected over a period of years. The confidence of farmers

in the future has been undermined as a result of their experiences since the War of 1914–18, and much will depend on the extent to which confidence can be restored as a result of the Government's recent policy.

What is now called for is intensive research at a central station on the many questions that would arise in connexion with the conversion of permanent into temporary grassland, together with a close study of local conditions, favourable and unfavourable, for the extension of ley farming, by economists and other scientific workers in different parts of the country. Sir George Stapledon himself is at some pains to explain that he is not an economist; all the more need that we should put the economist on his tracks! He has already persuaded a number of farmers to adopt his advice, and the results secured by men who have successfully turned from permanent to temporary grass farming would be of much value. Relatively the number of men concerned may be small, but I believe that they are sufficiently numerous to provide us with guidance of a kind that we cannot afford to neglect.

There are, indeed, features in the present situation which suggest that there is much scope for the economist, and not only in connexion with the interpretation of the experiences of grass growers. All readers of agricultural journals know that, in spite of agriculture's depressed state, there are within the industry many enterprising men who are doing well both for themselves and for their land. Their methods are certainly worth study and exposition, and the audience waits. Thanks to such movements as the Young Farmers' Clubs and to the facilities for training provided by Farm Institutes, there are now in Great Britain a large number of lads and young men keenly interested in agricultural progress and anxious to learn. Economic studies of the methods of successful men would be welcomed by these learners and by them would be translated into practice later on. The young farmers of my generation learned chiefly by example, and no doubt the young farmers of to-day continue to do so; but to-day, much more than formerly, they are so trained as to welcome precept, if precept is based on economic studies of the kind I have in view. Thus in the process of converting some four or five million acres now in permanent grass into temporary pastures, which would be necessary to fit England to respond rapidly, as Scotland already can, to the call for increased food supplies, I lay much stress on the assistance which the economist can give.

The awakening of the soil, which would follow the breaking up of permanent grassland, would intensify the programmes of most other scientific workers and in some cases would call for substantially increased activity. This would be the case especially in agricultural engineering. Whether in tilling a larger area in normal times, or in rapidly extending the tillage area in war, no form of aid would be more welcome to the farmer than aid in selecting and employing machines and implements that would enable him to use manual labour to advantage.

Many other matters would call for the attention of the scientific worker in war; some of them could be predicted because of 1914–18 experience, others could not, for one thing learned in 1914–18 was that war throws up new and unexpected problems. On the precise nature of these problems we need not now speculate; rather let us note that the scientific worker is confronted with one very definite objective. This objective, which must be approached from different angles, may, in a sentence, be stated to be the preparation of British agriculture to expand its normal output of food rapidly if called upon to do so. The immediate aim should be the provision of a six months' supply of food for the nation in an emergency.

Many of those who have considered the subject of food supply in war would not agree with the views I express; they would point to agricultural experience in recent years and argue that the production of half the nation's food from the soils of Great Britain would be impossible. But while I admit that experience since 1919 has not been encouraging, my view is that our present tendency is to underestimate the capacity of our agriculture, and I claim that our outlook should not be restricted by the experience of the past twenty years.

There is little amiss with the soils, or the climate, of Britain; our tillage land responded well to the calls made on it a century ago and would respond again. Our farmers taught those of most other countries, and if their pupils are now, in some cases, ahead of them, there is no lack of farming talent. Research and education in agriculture have been with us for a generation; growth may have been slow at first, but advances are now being made at a rate that is encouraging, and we may confidently expect much more aid from science in future than it has given us since 1919. Thus, from the technical point of view, I see no insuperable difficulties in the programme I have outlined.

From the point of view of farmers themselves, however, the case is otherwise. If they and their employees are to earn as meagre a share of the national income in future as they have done in the past twenty years, a further decline in the arable area is only too likely, for the reason that, under recent conditions, masters and men have lost confidence in their future prospects.

There is an atmosphere of 'defeatism' about, and not only among agriculturists themselves. There is too ready an acceptance of the doctrine that economic changes have condemned the land of England to slumber under grass, and that economic reasons forbid its awakening by the plough. As matters are, it would certainly cost the nation money to bring several millions of acres back into arable cultivation and to substitute temporary for permanent pastures; but if the change were made, not only would we add largely to the agricultural output, but also there is at least a prospect that farmers would find themselves better off than they now are. In my judgment the ease with which tolerably good grass can be grown in many parts of England has led far too many farmers to bury their talents under the green sod, and too many farmers, as well as their counsellors, believe that it is prudent to leave these talents buried; but looking to the future I am satisfied that good and faithful service to the country calls for a change, and, I hope, for a change that would be rewarded. To science I look for assistance in bringing this change about and, for the farmer's reward, to the belief that the world's non-agricultural inhabitants cannot expect a continuation of the conditions which, during the past century, have enabled them to buy their food at less than cost price. But these conditions may not quickly alter, while changes in farming are needed now, and as I have admitted that the nation must pay before large changes in our methods of cultivation can be expected, I will be asked: Why should the nation pay?

Whatever the next year or two may hold in store, Britain, hateful as the prospect may be, cannot afford to neglect preparations for defence. In these preparations agriculture must have a place. How large this place should be is a matter of opinion. My personal view, based on experience gained during 1914–18, is that it should have a large place; but be its place large or small, it is for services rendered in connexion with defence that farmers can legitimately ask the nation to pay, as it is paying, and paying heavily, for the services of others similarly engaged.

Thus looking to the future I conclude that the century-old motto which heads my paper is still applicable; the nation which relied on the British farmer for its food supply in 1839 cannot do without his aid in 1939; while he himself, if he is to do his part as his forefathers did, must take as his watchword "Practice with Science".

NUCLEAR REACTIONS IN STELLAR EVOLUTION*

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(3). Apart from the stars of the main sequence, there is known a large class of stars having very high luminosities but possessing much lower effective temperatures (that is, much greater radii) than the stars of the main sequence of the same luminosities. In the Hertzsprung–Russell diagram these so-called *red giants* form a rather irregularly distributed group on the upper right side of the main sequence. Because of anomalously large radii these red giants possess very low densities, and the estimated central temperatures are considerably lower than those for the stars of the main sequence (for typical red giants the central densities can be as low as 5×10^{-7} gm./cm.^{3}, and central temperatures less than 1×10^6°C.). Thus it is clear at once that the energy production in these stars cannot be due to the same nuclear reaction as in the stars of the main sequence, and we have to look for reactions taking place at an appreciable rate at much lower temperatures than the carbon-nitrogen cycle. From Table I [p. 575] we see that the nuclei which can be responsible for the energy production at lower temperatures are the isotopes of heavy hydrogen, lithium, beryllium and boron, and, using the data of this table together with formula (1), it is easy to estimate at which temperatures these different processes will be of importance. Then, using the homology transformations, we can calculate the location of stars with different energy-producing reactions in the Hertzsprung–Russell diagram[4].

The result of such calculations shows that stars with different energy-producing reactions should be located within different rather broad bands running parallel to the main sequence. The central lines of these various bands are shown in Fig. 2 together with the central line of the main sequence. It is interesting to notice that, whereas the bands corresponding to the reactions of the isotopes of hydrogen and lithium are very close together, the bands of ^{10}B and ^{11}B are widely separated. This comes from the fact that the two isotopes of boron lead to quite different nuclear reactions, one being

*Continued from page 577.

the radiative capture and the other the much more probable splitting into three particles.

In order to notice this 'lateral structure' of the red-giant region, it is most convenient to use the observational material on the *pulsating stars* which, as well known, form a one-dimensional sequence, all their properties being the functions of their (directly observable) pulsation period. In Fig. 2 the region of pulsating stars is shown by a shaded area, its width at each point being proportional to the number of stars observed. We see that there are definite concentrations of stars near the places where the different thermo-nuclear reactions of light elements, calculated as indicated above, become of importance. The short-period group of cluster-variables contains the stars in which the transformations of ^{10}B probably take the main role. The second group includes the *Cepheid variables*, the number of which shows a broad and irregular distribution as a function of the period; this is probably due to overlapping of three separate groups corresponding to the reactions of $^{6;7}Li$, ^{9}Be and ^{11}B. Finally, the group of the *long-period Mira-type variables* should be interpreted as due to deuterium (and possibly ^{3}H). It can be seen that the calculated effective temperatures for the stars of this group are considerably higher than the values actually observed. It must be due, however, to the fact that these stars show abnormally high central condensations[9] and the observed effective temperature actually corresponds to the extremely rarified outer atmospheres surrounding the main body of the star.

The same kind of 'lateral structure' would be also expected for the non-pulsating red giants, and, as a matter of fact, something of this kind can be seen in the diagram, where all stars with known characteristics are plotted; however, due to large errors of the parallax measurements of these stars, the structure is not so definite as for the pulsating variables.

Inasmuch as the light elements responsible for the life of red giants do not possess regenerative properties like carbon and nitrogen, and are permanently destroyed in the process of energy production, the life-periods of a star during which the different reactions mentioned above are of importance are very short as compared with the time a star spends on the main sequence. As soon as one of the light elements is consumed, the star undergoes a comparatively much faster, gravitational contraction until the central temperature reaches the value suitable for the beginning of the reaction of the next element. The evolutionary track of such a star is shown by a heavy line in Fig. 2.

Now we come to the discussion of a very peculiar feature of the Hertzsprung–Russell diagram. It has already been pointed out that the pulsating variables are distributed along a definite line crossing various bands of the red-giant region. It is also known that this line represents *an upper limit* for the distribution of red giants, and that almost no stars are known between this line and the upper part of the main sequence. What is the physical meaning of this limiting line, and why do the stars begin to pulsate when they approach this line in the process of their evolution? The answer to this question can probably be found[10] by considering the relative importance of the production of thermo-nuclear and of gravitational energy in a red

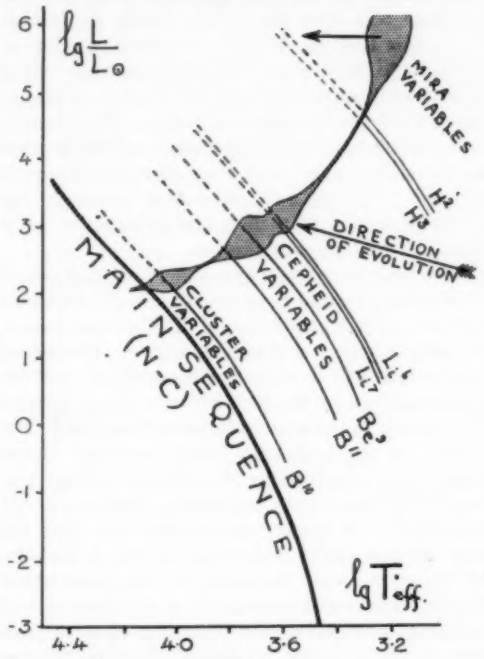

FIG. 2.

giant. If $-dX_1$ represent the decrease of the content of the light element responsible for the reaction, the total amount of the liberated energy will be evidently given by $Q.dX_1.M/m$, where M and m are the masses of the star and of the atom of the element in question and Q the energy liberation per nucleus. According to the homology transformations, the decrease of X_1 will cause a corresponding decrease of the radius of the star which, in its turn, will lead to the liberation of a certain amount of gravitational energy. The condition that this additional liberation of energy can be neglected as compared with the nuclear energy is evidently:

$$d\left(\frac{GM^2}{R}\right) < QdX_1 \frac{M}{m_0}, \qquad (5)$$

which can also be written, using the homology relation between R and X, in the form:

$$\frac{R}{M} > \frac{1}{n+1\cdot75}\ \frac{Gm_\odot}{QX_1}. \qquad (5^1)$$

Remembering that $M \sim L^{1/3}$ an ! $R \sim L^{1/3}\,T_{\text{eff.}}^{-3}$, we can write our condition for the critical line in the form: $L \sim T_{\text{eff.}}^{12}$, which roughly coincides with the equation of the line of pulsating variables. Moreover, substituting the numerical values, we find that the line given by this condition really passes through the location of these stars in the diagram. *Thus the line of the pulsating stars represents the geometrical locus of points where the gravitational contraction begins to play a more important part than the nuclear energy production.* Above this line no 'lateral' structure can be expected, and any star goes through this region rapidly contracting and radiating the gravitational energy liberated in such contraction. This process stops, however, as soon as the star reaches the main sequence where, due to a very high abundance of hydrogen, the energy liberation through the catalysing action of carbon and nitrogen becomes again the predominant process.

Let us now imagine a star which has just passed this limiting line and the source of energy of which is therefore mostly gravitational. If, for some reason, the radius of the star decreases slightly, the central temperature will increase correspondingly and the nuclear energy production will become of importance, giving to the star an impulse to expand. But as soon as the expansion starts and the central temperature again drops, the nuclear energy production becomes again negligible as compared with gravitation. It is easy to see that *this effect will cause an undamped pulsation*—in which the star will be, so to speak, 'bouncing on the critical line'. The pulsation will last as long as there is still sufficient amount of the reacting element, and there is every reason to believe that *the observed pulsations of stars near the limiting line are due to such a process.* After the amount of the element responsible for the pulsation becomes quite negligible, the star will rapidly pass the region of gravitational contraction and will become a star of the upper part of the main sequence.

(4). It remains now only to consider the later stages of stellar evolution, when the star, after staying sufficiently long in the main sequence, has consumed all its original content of hydrogen and enters into the stage of the final gravitational contraction. It is known[11] that the final stage of such contraction depends essentially on the mass of the star.

If the mass of the star is smaller than *the limiting value* $1\cdot4\ M\odot$ (for stars completely deprived of hydrogen), a degenerated electron gas will begin to be formed at a certain stage of contraction, and the star will tend to the state of very high density and low luminosity characteristic of the stars known at present as *white dwarfs*.

For stars of larger mass, no lower limit of contraction exists, because the gravitational pressure of the outer layers cannot be balanced at all by the pressure of the degenerated electron gas. At a certain stage of the contraction one may expect that *in the interior of the star a large amount of free neutrons will begin to be formed*, leading to a rapid collapse of the whole star and to the liberation of tremendous amounts of gravitational energy[12].

The question as to how such explosions can be connected with the observed phenomena of *novæ* and *supernovæ* is not yet quite clear, and we will not enter here into its discussion.

Summing up, we can say that, due to the application of our present knowledge of nuclear physics, the problem of stellar energy sources and the main features of stellar evolution can be considered at present as practically solved.

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[13] Baade, W., and Zwicky, F., *Proc. Nat. Acad. Sci.*, **20**, 259 (1934).

SUBSTITUTES FOR PETROL

THE need to conserve available supplies of petrol and the consequent severe restriction of the amount allotted under the rationing scheme in Great Britain, raises a question as to the applicability of other fuels to the ordinary motor-car or trade vehicle. It has to be borne in mind, however, that at the present time no fuels should be used except for good and sufficient reason, as fuel is a vital supply in the conduct of modern war.

The fact that town's gas was quite largely used in the years 1915–17 as a motor-car fuel suggests that it might once more be brought into service. It will be recalled that the cycle of operations in the petrol engine is essentially the same as that employed in the gas engine. In the former, the liquid fuel is atomized, metered and mixed with air by means of the carburetter, which also provides the means of controlling its flow. When gas

is to be used, a diffuser of much simpler construction than the modern petrol carburetter can be employed, the mixture of fuel and air being effected by a gas supply pipe of about three eighths the diameter of the inlet pipe. On the gas supply pipe a regulating valve is necessary; this might be of the needle type and it might be arranged to operate in conjunction with the accelerator pedal. A main gas tap is obviously needed, because when the engine is shut down the gas must be turned off. For perfect combustion about 6 volumes of air must be supplied; but for economical results 8–10 volumes are better. The power obtainable will be somewhat less than from petrol, but there should be some saving in cost per mile.

For the storage of gas, large and cumbersome gas-bags were used, the obvious place for which is on the roof. As an alternative, steel cylinders containing high-pressure gas can be carried, but as these would generally have to be given some of the interior space of the car, their presence would doubtless be found less acceptable than the swaying bulk of the gas-bag overhead.

The use of gas is in the nature of a reversion to an older system; but it cannot be said that the newer systems offer any possibility of ready adaptation to existing cars. The heavy oils used in Diesel or semi-Diesel engines require a quite different cycle of operations and therefore an essentially different engine. The direct use of powdered fuel is making headway; but it would necessitate an engine approximating to the heavy-oil type. A further possibility is that of generating coal gas for the use of the engine; but this would involve the provision of extra plant as well as the adoption of a new technique by the driver.

The most immediately hopeful change-over will, therefore, be to the gas-bag, out of place as it may appear on a smart car. Some gas companies are understood to be planning the supply of gas in bags both at their works and through the garages and service stations, and it may be anticipated that they will arrange also for the provision of gas-carburetters or diffusers so that an easy change-over may be effected. The subject has received little attention in the text-books and reliable data are difficult to obtain. In "Carburetters and Fuel Systems" by A. W. Judge (third edition), illustrations of several carburetters will be found and quite a lot of practical information that would be most useful to anyone considering making this change.

OBITUARY

Mr. Sydney Evershed

MR. SYDNEY EVERSHED died on September 18, at the age of eighty-two years, at his home in Ealing. He had been associated with the manufacture of electrical testing instruments for fifty-three years. As an inventor his influence can be traced in the development of many electrical instruments in many countries in the world. He was the son of John Evershed of Gomshall, Surrey, and his younger brother John, the well-known astronomer, a fellow of the Royal Society, now resides at Ewhurst, Surrey.

At a meeting of the Institution of Electrical Engineers held in 1922 to commemorate the first ordinary meeting of the Society which was held fifty years previously, Mr. Evershed gave some interesting reminiscences of his own early life. In 1876, the year of the Centennial Exhibition in Philadelphia, he read in the newspaper of someone having listened to Hamlet's soliloquy being spoken by Dr. Graham Bell's telephone, and was lost in amazement, as at that time it was commonly believed that this would have required thousands of musical reeds. A year later he saw a drawing of a telephone and was surprised to find how simple its mechanism was. With the help of two baking-powder boxes in which he cut holes in the lids with his knife, a small bar magnet and some silk-covered wire wound round one pole, and a disk of thin sheet iron, which he cut with scissors, near the other, and using a long piece of telegraph wire to form the connecting line between the two crude telephones, he found to his amazement that they worked admirably, the speech transmitted being practically perfect.

He remembered in his own early life in Surrey the days when you saw only one arc lamp at a time, and what a great blaze of light it made to people accustomed to the dingy gas lights in the streets! In these days a strenuous research was being made 'to subdivide the electric light'. There was great excitement amongst the physicists when a cablegram came from America saying that Edison had succeeded in dividing it by means of a platinum incandescent lamp. Contemporaneously with this feverish research, Joseph Swan was working in England on his carbon vacuum lamp.

Evershed was then living a few miles from the town of Godalming in Surrey. Strange to say, this quiet Surrey village was the first town in England to light its streets by electricity. A dynamo was installed in Pullman's leather mills, not far from the town, on the river Wey, where water-power was available. The electric lighting of Godalming began on December 15, 1881. He remembered, on a later date, seeing the leather mills lit up with what he was told were Swan lamps. A leather worker with whom

he spoke had a Swan lamp all to himself, but he admitted that he preferred a tallow candle. The main street of the town was illuminated by three arc lamps and the smaller streets by Swan lamps. The electric cables were simply laid in the gutter. He remembered kneeling on the pavement and putting a charm compass close to the cable and being very puzzled because he got no deflection. It was his first experiment with alternating current. In about a year afterwards Joseph Chamberlain's Electric Lighting Act was passed, and the newly born industry of electric supply was practically snuffed out for six years.

In 1886, taking with him samples of measuring instruments of a moving iron type which he had made with his own hands, Evershed applied for and obtained the position of manager of a little factory established by the firm of Goolden and Trotter in Westminster for the manufacture of Cardew hot-wire voltmeters, for which there was then a considerable demand in the Navy. Captain Philip Cardew had invented this instrument two years previously. It was the first of its kind and in many ways was most suitable for its purpose.

After several changes of name the firm became Evershed and Vignoles, Ltd., with Mr. Evershed and Mr. Vignoles as managing directors. In 1889 Mr. Evershed introduced his portable ohmmeter and hand generator. From this date the measurement of the insulation of house wiring ceased to be a laboratory operation. In 1903 he completed his invention of the moving-coil ohmmeter. He combined the high-voltage generator and ohmmeter in one box in such a way that there was no magnetic interference and the instrument called the 'megger' was in demand in practically every country in the world.

The firm built a large factory called 'Evershed and Vignoles' near Chiswick Park Station. In 1924 Evershed gave up his position as managing director but remained as chairman until he retired in 1938.

In 1931 Evershed was asked by the Council of the Institution of Electrical Engineers on the anniversary of the birthday of David Hughes to give a discourse on his life and work. He gave a most enlightening discourse, dwelling mainly on the two outstanding achievements of his life, namely, (1) the invention in his early years of the synchromonotype-printing telegraph and (2) in later life the discovery of the microphone. In reading this discourse you get a deep insight into the life and work of this great inventor. At the receiving end the message was printed on a paper ribbon by the action of an electromagnet in the circuit. Each time the contact arm at the sending end passed over a live stud, a current traversed the line and the electromagnet. The armature of the magnet forces the paper ribbon into momentary contact with the type-wheel and a letter is printed. Only one impulse was required for each letter.

Mr. Evershed's special knowledge of the magnetic properties of alloys of iron and of their use in instrument making greatly impressed scientific visitors when they came to meetings of the Institution and at Council dinners. He often spoke in discussions at the Institution of Electrical Engineers, where his humorous touches always pleased his audiences. The first time the writer heard him speak was in 1891 when J. Swinburne (now Sir James) read a paper on transformer distribution and W. Crookes was in the chair.

In 1899, G. Marconi read his classical paper on wireless telegraphy to the Institution of Electrical Engineers, Prof. Perry being in the chair. In this paper he mentions how he demonstrated the feasibility of signalling between Ballycastle and Rathlin Island in northern Ireland, the distance between the two positions being 7½ miles. Mr. Evershed, who spoke in the discussion, said that he had been working on telegraphy to lightships for many years. One of his suggestions which was submitted to a Royal Commission was tried and found to be a total failure. He therefore desired to be the first to congratulate Mr. Marconi very heartily on having succeeded. Evershed was always delighted and pleased with other people's discoveries.

In 1900 the writer remembers him reading a paper on a 'frictionless motor meter'. He forestalled criticism by pointing out that the adjective 'frictionless' was used in the comparative sense, just as we say 'smokeless' powder or a 'water-tight' compartment. The floating armature was magnetically suspended when working and its vertical axis was pivoted at the lower end.

In his early years Evershed investigated the phenomena exhibited by insulating materials when under electrical stress. His results are given in a paper read before the Institution of Electrical Engineers in 1913, and papers presented to the same Institution in 1930 and 1935 gave the results of his work on permanent magnets which yielded data that enabled scientific design to be substituted for rule-of-thumb methods.

Evershed was for several years a member of the Council and a vice-president of the Institution of Electrical Engineers. The writer knows also that he was invited on more than one occasion to be president. His portrait, painted by Mr. George Harcourt, R.A., was presented to him by his firm to commemorate his fifty years connexion with it. It is now in the keeping of the Institution of Electrical Engineers.

A. R.

WE regret to announce the following deaths:

Prof. G. F. Arps, professor of psychology in the Ohio State University, on September 16, aged sixty-five years.

Prof. Henry C. Cowles, emeritus professor of botany in the University of Chicago, on September 12, aged seventy years.

Sir Spencer Lister, director of the South African Institute for Medical Research, known for his pioneer work on pneumococcal vaccines, on September 6, aged sixty-three years.

Prof. R. S. Troup, C.M.G., C.I.E., F.R.S., professor of forestry in the University of Oxford, director of the Imperial Forestry Institute during 1924–35, on October 1, aged sixty-four years.

NEWS AND VIEWS

Prof. M. von Laue

ON October 9, Dr. Max von Laue, professor of theoretical physics in the University of Berlin, will be sixty years old, and we take the opportunity to congratulate him on his brilliant scientific work, and especially on his conception of the diffraction of X-rays by crystals, which has led to the development of more than one new and important branch of science. In 1912, Dr. von Laue made the fundamental suggestion that crystals, which had long been believed to contain a lattice structure regularly repeated in space, might behave towards X-rays as a diffraction grating behaves towards light. He worked out in some detail the diffraction effects to be expected from such a three-dimensional grating, and his suggestion led directly to the experimental discovery of the diffraction by his collaborators Friedrich and Knipping. The diffraction pattern obtained when a beam of X-rays of mixed wave-length falls on a crystal is now universally known by his name. The immediate effect of the discovery was to settle the contemporary discussion about the nature of X-rays. The work was immediately taken up by scientific men in all countries, including, of course, the Braggs in England, and, in the years that followed, the diffraction of X-rays has developed into our most powerful method for studying the structure of aggregated matter. Its significance for the biologist is, perhaps, only beginning now. In these days of international antagonism, it is well to note that the branch of science initiated by von Laue has developed by the co-operative effort of men of all nations. Dr. von Laue has numerous friends in Great Britain; all of them hope that he has yet many years of fruitful work before him.

The Central Register: Section for Scientific Research

THE Royal Society, at Trinity College, Cambridge, has sent a communication in connexion with the Central Register to the heads of scientific departments in universities, firms, etc., who supplied the Royal Society with lists of persons recommended for the Register. It is pointed out that the Central Register is now being used by the Ministry of Labour for filling vacancies. Some classes are being absorbed rapidly, others only slowly. To obviate hardship, particularly in the latter, it is proposed, in the Scientific Research Section, to make an urgency list of persons who are now unemployed, or whose present jobs are coming or likely to come to an end. This list will be given to the Ministry and, where possible, vacancies will be filled from it. The original lists of recommendations for inclusion on the Register are being returned with the request that names of those who should be placed on such an urgency list should be specially marked. The Royal Society is aware that many scientific people anxiously await information as to whether and when use will be made of the offer of service implied in their registration. No general answer can be given. The absorption of scientific personnel is proceeding, but this is bound to take time, and there is no certainty that every volunteer can be used in his professional capacity. In view of future needs, many will be best advised to remain in their normal occupations for the present. It is permissible, however, to seek employment, with the defence services or otherwise, which is not inconsistent with the Schedule of Reserved Occupations. If doubt exists, the Ministry of Labour can consult the appropriate panel. If employment in national service is obtained otherwise than through the Central Register, the Ministry of Labour should be informed.

Scientific and Industrial Research in India

THE report of the Industrial Research Bureau, Government of India, for the year 1938–39, covers work carried out on the development of Indian industrial research and industry by the Bureau, including that of the Industrial Research Council and of the Research Branch of the Government Test House, Calcutta. The Bureau itself has been responsible for work on casein plastics and has shown that high-grade rennet casein is required, while the resin at present produced in India is of the lactic acid type, which is inferior for this purpose. A modified technique for the preparation of rennet casein suitable for operation under Indian climatic conditions requires development by laboratory investigations. The Bureau has also examined the economic and technical possibilities of manufacturing both rayon and staple fibre in India by the viscose, as well as by the acetate, process. It has continued its co-operation with the Central Standards Office Railway Board in matters concerning the lubrication and painting of railway rolling stock. With the view of developing the manufacture in India of phenol and formaldehyde for use in synthetic resins for moulding powders, disinfectants, etc., arrangements have been made for investigations of crude tar acid and phenol-cresol products from the cold distillation plant in Bihar. The Indian Lac Research Institute at Ranchi has obtained promising results in developing a shellac-urea-formaldehyde moulding powder.

THE Research Branch of the Government Test House, Calcutta, has continued its paint investigations, covering revised technique for the assessment of natural weathering of paint as well as accelerated weathering, and the investigation of paint formulæ. The setting of pigments and the dispersion and suspension of red lead pigments have also been investigated, including weathering tests with dispersing and suspending agents, which indicate that the use of aluminium stearate is in no way harmful. Studies of particle size have indicated that aluminium stearate reduces the particle size of the red lead pigment to a remarkable degree. Investigations of

the growth of fungus on paint films on exposure to weather indicate that substances such as sodium silicofluoride, magnesium borate and tribromophenol, which have proved effective in Western countries for preventing fungus growth, are of very little value in Bengal, but mercuric oxide and mercuric phthalate appear to retard the growth of fungus perceptibly. Work on vegetable oils and lubricants included a search for more effective antioxidants for castor oil in presence of iron, as well as for ground nut oil and for cottonseed oil. The most effective antioxidants found so far for cottonseed oil are not quite effective enough, and the best antioxidants for ground nut oil are less effective than those found for castor oil. Attention is now being confined to castor oil and ground nut oil brands, for which purpose α-naphthol, α-naphthylamine and β-naphthylamine appear to be the most effective antioxidants. Other studies have covered the use of vegetable oils as diesel oils. Work carried on in connexion with the glass industry has covered the improvement of glass furnaces and accessories.

Delinquency and Psychology

IN the July issue of the *Quarterly Review*, Mr. Claud Mullins, the well-known Metropolitan Police Court magistrate, remarks that some believe that the discoveries of modern psychology completely rob our present methods of trial and punishment of all justification, and that nearly all who have committed any serious breach of the criminal law should pass into the hands of psychotherapists and thus be cured, while others deny that our present legal and penal methods are in any way affected by psychology. Both extreme opinions, however, are gradually diminishing. Psychotherapists, by closer contact with delinquents, have become more modest in their practical attitude, while magistrates and lawyers are beginning to realize that psychologists can be of assistance. Mr. Mullins himself has sent innumerable delinquents to psychotherapists, and in many cases has found the results satisfactory. It must, however, be borne in mind that psychologists are concerned mainly with an individual while the Bench is concerned also and mainly with society. Certain criminals, such as fraudulent financiers, fire-raisers, stealing postmen or railway servants, policemen who accept bribes and alcoholic motorists who kill or maim, cannot be dealt with solely or even mainly from the point of view of what is best for the delinquent, and in such cases severe punishment is required to discourage others. While regarding it as highly dangerous for the Bench to assume the functions of the psychotherapist, Mr. Mullins maintains that some knowledge of psychology and psychotherapy is desirable alike in the judge, recorder, stipendiary magistrate and lay justices.

Museums and Education

SIGNIFICANT of the new stress being laid upon the educational possibilities of museums was the presence of the President of the Board of Education, the Right Hon. Earl De La Warr, at the Jubilee Conference of the Museums Association, held at Cheltenham in July. In an address to the members the President of the Board gave clear evidence of his own interest in museums and indicated that, but for the special financial condition of Great Britain, he would have announced the setting up of an inquiry into the relationships of museums to education and to the State. On the whole, he seemed to be doubtful about the expediency of bringing the museums of the country under the control of the Board of Education, believing that freedom of initiative was greater under the present system, and that a happy combination of official help and collaboration with local or voluntary effort was a source of strength in many spheres of work in Great Britain.

THE same point from another angle was referred to in a subsequent discussion at the Conference by Mr. J. Wilkie, secretary to the Carnegie United Kingdom Trust. He pointed out that at present, so far as legislation goes, museums (other than national museums) are almost all linked with libraries and library authorities under the Public Libraries Acts of 1892 to 1919. But these Acts are adoptive, and there is no Government grant in aid of any service which is carried out under an adoptive Act. So that the Markham Report, in suggesting Government grants with some measure of control, is suggesting something quite revolutionary in library and museum policy—the substitution of a compulsory for a voluntary system. That was the problem which faced educational reformers in 1870, and it raises the question whether public opinion, as represented by the man in the street and the public authority, has reached that point of belief in the necessity of museums as educational institutions which would compel the museum service to be made comprehensive, universal and compulsory. Are compulsory museums to follow compulsory education? An account of these discussions appears in the *Museums Journal* of September.

Anthropological Expedition to Brazil

A PRELIMINARY report, the first to appear, on the movements and work of the expedition to Matto Grosso, Brazil, of Dr. Levi-Strauss and Dr. J. A. Vellard, based on the infrequent telegraphic dispatches which had been received to the time of writing, has been published in the *J. de la Société des Américanistes*, N.S., 30, 1939. The expedition started from São Paulo in May 1938, and, proceeding along the line of the Rondon telegraphic system, made telegraph stations its bases for contacts with the Indians. At Utiarity, Juruena, Nhambiquaras, and Vilhena relations were established with various groups of the Nambikwara, of whom there are approximately 2,000 individuals in a territory extending 400 kilometres north of Utiarity. Three linguistic divisions were differentiated. The material culture was poor; but evidence was obtained of their social organization, system of relationships, family life, and of certain aspects of their technology and art. By October the expedition had arrived at Pimento Bueno, which was selected as a base for

further research. Here visits were paid to groups belonging to Guaporé culture, but not classified linguistically. A prolonged stay in a village halfway between Presidente Hermes and Presidente Penna, of which the inhabitants were numerically poor and culturally degenerate, nevertheless proved fruitful in sociological material. Towards the end of the year, on reaching Presidente Penna, the return of the expedition by the normal route towards the south was barred by torrential rains and the ill-health of the members of the expedition. It was, therefore, decided to leave the country by the north in the direction of the Rio Madeira and then west to Bolivia.

Research on Lawns

INVESTIGATION of the particular ecological problems which relate to lawns began in America towards the end of last century. It was not until 1920, however, that such research was prosecuted on a national scale in that country, and not until 1925 that any adequate provision was made in Great Britain. The report for 1938 of the Board of Greenkeeping Research, St. Ives Research Station, Bingley, Yorks. (pp. 1–77, price 2*s*., July 1939) shows to what adequate development the investigation of greenkeeping matters has now attained. There are approximately 1,600 experimental plots at the Station, to inquire into the response of grass varieties to manurial and mechanical treatments, to control pests and diseases, and to select the most suitable varieties of grass for various purposes. Seed of the new strain of St. Ives Creeping Red Fescue is grown and distributed, whilst an improved strain of *Agrostis tenuis* should yield upon a small commercial scale in 1939. Experiments on the control of pearlwort and other weeds are in progress, the effects of sulphur as a dressing for heavy ground are being investigated, treatment of the soil with potassium permanganate for the control of earthworms has proved satisfactory, and various diseases of turf have also been studied. The Station now maintains an extensive permanent collection of greenkeeping implements, and has 'museum' plots of grass and weed species—features which are of great value to students who attend the two courses of instruction which are held during the year. Letters and advisory visits have reached higher maxima than in any previous year, and the results of the Station's researches are published in its *Journal* and in various reprint publications.

The Electric Battery Vehicle

ACCORDING to the *Electrical Times* of September 28, one result of the outbreak of war is a considerable increase in the number of inquiries received by manufacturers of electric accumulators and vehicles as to the price of their wares, the charges of electricity required by the vehicles and the distance traversed for a given charge on a smooth road. Petrol rationing has compelled owners of motor-vehicles to curtail seriously their usual transport facilities, and they are considering the relative advantages of petrol and electricity for transport. Since electric vehicles take their power from storage batteries they are designed as a rule to have only a moderate range of action, varying from about 25 to 45 miles per charge of the batteries. The distance depends on the number of stops that have to be made. If the number of stops are numerous and the average time of a stop long, the advantage lies greatly on the side of the electric vehicle, since it only takes power when it is running. Most retail deliveries are carried out on a 'customer convenience' basis and not on 'transport economy basis'. It has been estimated that the petrol ration for C licence holders is only sufficient for their vans and lorries to cover half the normal mileage. If they have been doing about 75 miles per day, then they would be able to substitute an electric vehicle and still be in the same position as at present. For any distance between 35 and 75 miles per day, an electric vehicle would be an excellent substitute for a petrol one. The electric vehicle has other advantages. It has a long life; low maintenance and cheap running costs enable it, for many duties, to prove superior to alternative transport methods. In addition, it has the advantage of being exceptionally clean, free from fumes and simple to operate. A one-ton carrying capacity petrol van running 10,000 miles a year will use about 650 gallons of petrol, whereas the electric will use 4,000 units of electricity, or about 3 tons of coal. Owing to the grid, if at any time difficulties in transport should arise, then those power stations involving the minimum amount of coal transport could take over much of the load.

Properties and Testing of Heat-Insulating Materials

A GENERAL discussion on "The Properties and Testing of Heat-Insulating Materials", organized by the Joint Committee on Materials and their Testing, in conjunction with the Institution of Gas Engineers, will be held in London on November 23. Authorities from Great Britain, the United States, France, and Canada are to take part. Further particulars can be obtained from the Secretary, Joint Committee on Materials and their Testing, Institution of Mechanical Engineers, Storey's Gate, London, S.W.1.

Chemical Society

THE Chemical Society will continue to function at Burlington House, London, unless circumstances render it impracticable to do so. It is the intention of the Council to publish the *Journal of the Chemical Society* each month as heretofore and to issue the "Annual Reports on the Progress of Chemistry, 1939" in the early spring of 1940. *British Chemical and Physiological Abstracts* "A", *Pure Chemistry*, will also continue to be published monthly. The Council has accepted with great regret as from September 30 the resignation of Prof. J. W. Cook from the office of honorary secretary, on his appointment to the regius chair of chemistry of the University of Glasgow. It has expressed its high appreciation of the eminent services Prof. Cook has rendered to the Society during his term of office. Prof. W. Wardlaw, professor of physical chemistry in Birkbeck College, London, has

been appointed by the Council to fill the vacancy until the next annual general meeting. The programme of lectures, discussions and meetings of the Society for the reading of papers, arranged for the session 1939–1940, will inevitably suffer drastic alterations. The Council hopes, however, that modified programmes will be carried out, and particulars of meetings will be announced from time to time. Until further notice the Society's Library will be open each weekday from 10 a.m. to 1 p.m., and from 2 p.m. to 5 p.m. or sunset when earlier, except on Saturdays, when the hours will be from 10 a.m. to 1 p.m. The Research Fund Committee will meet early in November to consider applications for grants for research purposes. These must be received by November 1.

Physical Society

A SPECIAL meeting of the Council of the Physical Society was held on Friday, September 22, to discuss the Society's activities in the immediate future. It was decided that the science meetings, the annual exhibition of scientific instruments and apparatus and the annual competition in craftsmanship and draughtsmanship should be suspended for the present, but that the publication of the *Proceedings* should be continued as usual. Volume 6 of the Society's annual "Reports on Progress in Physics" is now in the printers' hands, and it is hoped that this volume will be issued at the usual time—the end of the present year. The Council recently had under consideration a project to hold local meetings of the members of the teaching and research staffs of the physics and related departments of a number of the provincial universities and university colleges; normally two such meetings would have been held in each session in the physics departments of two of the universities concerned. The officers and Council hope that, even though this scheme may not be carried out in its entirety, it may still be possible for local groups to hold meetings of an informal type under the auspices of the Society. For the present, the business of the Society will be carried on at its office at 1 Lowther Gardens, Exhibition Road, London, S.W.7 (Telephone: Kensington 0048); all communications and the MSS. of papers submitted for publication by the Society should be sent to the honorary secretaries at that address.

Institution of Civil Engineers

IT is announced that the Council of the Institution of Civil Engineers has decided to continue, so far as may be practicable, the work of the Institution from the headquarters building in Great George Street, Westminster, S.W.1. The meetings of the Institution in London will be suspended until further notice, and the Conference on Engineering Education and Training and the Road Engineering Exhibition are postponed indefinitely. The October examinations of the Institution will be held in London, but not in the provinces. The Council will continue to co-operate in the work of the Central Register of the Ministry of Labour and to assist the War Office and other Service Departments in the recruitment of qualified civil engineers for posts in which their professional experience is of value.

Royal Institution

THE policy to be followed by the Royal Institution during the War has been under consideration by the managers, who have decided to maintain its normal activities so far as possible. The libraries and reading rooms will be kept open as usual. Although the present 'black-out' restrictions prohibit the holding of the Friday evening meetings, a series of afternoon lectures at an earlier hour is being arranged and will be announced in due course.

Royal Society

THE Royal Society will function normally during the war; the administrative office is located in Trinity College, Cambridge, and it is probable that the meetings of the Society will be held in that town.

Institution of Professional Civil Servants

THE Institution of Professional Civil Servants has temporary headquarters at 20 Cedar Road, Sutton, Surrey, to which communications should be sent.

Announcements

MR. W. C. WILSON, director of the unit for Clinical Research in Surgery at Edinburgh Royal Infirmary, has been appointed regius professor of surgery in the University of Edinburgh.

PROF. KWANICHI TERAZAWA, dean of the Faculty of Science of Tokyo Imperial University, has succeeded Prof. Mishio Ishimoto as director of the Earthquake Research Institute. Prof. Ishimoto will continue his researches as a member of the Institute.

DR. GERALD B. WEBB, research director of the Colorado Foundation for Research in Tuberculosis, has recently been awarded the Trudeau Medal of the National Tuberculosis Association in recognition of his attempts to produce specific immunity against tuberculosis by the inoculation of animals with very minute doses of tubercle bacilli.

CONSEQUENT upon the outbreak of war, the celebration of the Royal Microscopical Society's centenary this month is postponed, and a further notification will be issued in due course.

IT was announced in NATURE of September 30, p. 592, that the Imperial College is preparing to re-open most of its departments at South Kensington on October 10. We are asked to state that the date is not yet fixed and that students will be advised when to return.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 637.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Connexion between the Life-time of the Meson and the Beta-Decay of Light Elements

As is well known, the assumption of the instability of the meson, which is included in the fundamental hypotheses of Yukawa's theory of beta-disintegration, has received a striking qualitative confirmation from investigations of the absorption of the penetrating component of the cosmic radiation[1]. As stressed by Nordheim[2], there is, however, in the forms of the theory successively considered by Yukawa[3] a serious quantitative discrepancy regarding the value of the ratio between the life-times of the free meson and of *light* beta-radioactive elements: the value of this ratio, calculated by using the values of the constants determined from the magnitude of the nuclear forces, turns out to be much smaller than that derived from observation. Since this discrepancy affects equally any other form of the theory involving only one of the four types of meson fields which, according to Kemmer[4], are possible *a priori*, it may be concluded that no such form of the theory will be able to account quantitatively for the connexion between the life-time of the mesons and the beta-decay of light elements.

On the other hand, it is immediately apparent that the discrepancy in question can be removed as soon as a mixture of independent meson fields is introduced. Consider, for example, such a mixture of two fields A and B. The additive contribution of the field B to the beta-decay constant may then for some elements be much larger than that of the field A, while the life-time of the free mesons associated with field B will be so short compared with that of the mesons associated with field A that only the latter would have been observed at present in cosmic radiation.

Now a discussion of the problem of nuclear forces[5] seems to bring out the necessity of introducing just such a mixture of two types of meson fields, namely, a vector meson field and a pseudoscalar meson field. A closer investigation, which is being continued, shows that such meson fields give rise to an interaction between heavy and light particles which, besides a term of the same type as that assumed in the original Fermi theory of beta-decay, may involve several possible combinations of other terms of a more complicated form.

The resulting theory of beta-decay thus contains a certain amount of arbitrariness, which a comparison with the available experiments is not yet able to remove. Anyhow, it may be expected that it will enable us not only to avoid the discrepancy pointed out by Nordheim, but also to account for such considerable variations of the form of the beta-spectrum and the value of the beta-decay constant from element to element, as are already indicated by the present empirical data.

C. MØLLER.
L. ROSENFELD.
S. ROZENTAL.

Universitetets Institut for teoretisk Fysik,
København.
August 11.

[1] See, for example, Euler, H., and Heisenberg, W., *Ergebn. d. exakten Naturwiss.*, **17**, 1 (1938).
[2] Nordheim, L., *Phys. Rev.*, **55**, 506 (1939).
[3] Yukawa, H., *Proc. phys.-math. Soc. Japan*, **17**, 46 (1935); Bhabha, H., NATURE, **141**, 117 (1938); Yukawa, H., Sakata, S., Kobayasi, M., and Taketani, M., *Proc. phys.-math. Soc. Japan*, **20**, 720 (1938).
[4] Kemmer, N., *Proc. Roy. Soc.*, A, **166**, 127 (1938).
[5] Møller, C., and Rosenfeld, L., NATURE, **143**, 241 (1939): **144**, 476 (1939).

A New Technique for the Spreading of Proteins and the 'Spreading Number'

THE ordinary volatile solvents employed for fatty substances cannot be used for the spreading of protein monolayers on the surface of water, since the majority of proteins are soluble only in water. Hughes and Rideal[1] have spread proteins directly from the dry crystal, the amount spread being determined with a microbalance. Gorter and Grendel[2] deliberately inject an aqueous solution of the protein on the surface without worrying about the possible disappearance of a part of it in the substrate. Fatty substances and the exceptional protein, gliadin, have been successfully spread from alcoholic solution, in spite of the fact that ethyl alcohol is soluble in water. It appears that in this case, owing to its large spreading pressure, the alcohol spreads very rapidly before it has time to diffuse into the substrate.

Starting from these facts, a general method has been evolved for the spreading of proteins from aqueous solutions. The protein is dissolved in water, the surface tension of which is artificially lowered by adding traces of a capillary active substance, so that, when a drop is placed on the surface of the substrate, it quickly spreads. Once scattered, only the protein remains on the surface and the solvent dissolves in the substrate. As capillary active substance, amyl alcohol at a dilution of 1–2 per thousand has given very satisfactory results. The action is simply one of mechanical dispersion, and the same result may be obtained by using esters (for example, butyl acetate or propionate) as capillary active substances.

Various types of proteins have been thus spread on the surface of either distilled water or dilute hydrochloric acid or caustic soda. Particularly some globulins (for example, myosin, amandin, edestin) have been spread which were reputed not to form films,

or at least to spread only on very concentrated salt solutions. Below are given the areas in sq.m. per mgm. occupied by these different globulins. These figures are simply intended to show how the surface concentrations are comparable with those found for the ordinary proteins.

Areas in sq. metre per mgm. under 1 dyne/cm.

	Myosin	Amandin	Edestin
Dist. water	0·9	0·9	0·7
HCl *N*/1,000	1·1	1·3	0·9
HCl *N*/100	1·6	1·1	1·3

A substance may have a very low spreading pressure and yet be spread and give a film stable under relatively high pressures. It has to be emphasized that, with substances that do not spread spontaneously, one of the functions of the solvent is to disperse the molecules over the largest possible area. It is found that to obtain complete scattering, it is necessary to ensure that the concentration of the protein in the drop should be below a certain quantity, just as is the case with solutions of stearic acid or tristearin in a volatile solvent and gliadin in alcoholic solution[2].

The 'spreading number'. It has often been noticed that the spreading of a protein from a crystal is more difficult, if not impossible (for example, casein), at the isoelectric point. This is to be expected since at that point the solubility is at the minimum and, therefore, the work of adhesion being also a minimum, the spreading pressure is lower. This variation of the spreading pressure with the *p*H seems to be in contradiction with the results of Gorter and collaborators, who found a maximum of the 'spreading number' at the isoelectric point, when the protein was injected as a solution. The contradiction is only apparent and is due to the bad definition of 'spreading'. The point in question is rather the *spreading efficiency*: Gorter's curves showing the 'spreading number' as a function of the *p*H or the salt concentration are three-dimensional solubility curves and do not represent a surface phenomenon. In reality, if the substrate's *p*H corresponds to the isoelectric point of the protein, this, being at its minimum solubility, will spread before an appreciable quantity has time to dissolve. At other *p*H or salt concentrations, it will be more or less soluble and the surface concentration will correspond only to the part of the protein which is left on the surface.

In order to show that the variation of the 'spreading number' with the *p*H is in any case not a surface phenomenon, experiments have been made in which the *p*H of the substrate was changed under the monolayer, after this had been formed and the state of equilibrium reached[4]. A layer of egg albumin was spread by the Gorter and Grendel technique on *p*H 4·9 (*M*/1,000 acetate buffer). The *p*H of the substrate was afterwards brought successively to *p*H 3·2, 5·1, 2·6, then back to 4·9 and 11. The order of succession is immaterial: in one case, the film was spread on *p*H 7·8 (*M*/1,000 Co_2HNa) with the new technique and the *p*H afterwards brought to 4·9. The observed areas under 1·5 dyne/cm. are given below, the value 100 being arbitrarily attributed to the area at *p*H 4·9.

Egg albumin (relative areas under 1·5 dyne/cm.)

*p*H			*p*H	
4·9	100			
3·2	106			
5·1	100	7·8		97
2·6	108	4·9		100
4·9	100			
11	109			

If Gorter's curve represents the change of area occupied by a given quantity of egg albumin, the passage from *p*H 4·9 to 3·2 would have reduced the area to one eighth. Likewise, the film should extend 20 or 30 times by changing the *p*H from 7·8 to 4·9. Whereas in fact, as can be seen by the numbers above, the maximum variation in the area is at the most 10 per cent and the area is not even at a maximum at the isoelectric point. As noted by Philippi[5], a study of the complete isotherm shows that these relatively small variations in the area are entirely attributable to changes of the compressibility.

A more detailed account will be published elsewhere.

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August 16.

[1] *Proc. Roy. Soc.*, A, **137**, 62 (1932).
[2] *Trans. Farad. Soc.*, **22**, 477 (1926).
[3] See Mitchell, *Trans. Farad. Soc.*, **33**, 1130 (1937).
[4] There is in fact a 're-extension' surface phenomenon which occurs in certain circumstances: see, Dervichian, D., *C.R.*, **209**, 16 (1939).
[5] Philippi, "On the Nature of Proteins". Thesis, p. 71 (Amsterdam, 1936).

Comparison of the Adsorption, Electrolytic, and Interference Methods of Measuring Film Areas

THE Bowden-Rideal[1] electrolytic method of measuring area by the electrodeposition of hydrogen ions on conducting surfaces has been modified so that rapid measurements may be made by using audio-frequency alternating currents superposed on very feeble direct currents, and measuring directly the alternating changes of electrode potential with an amplifier and wave analyser with one megohm input impedance. Comparisons of surface areas were made by measuring the alternating current required to give the same alternating electrode potential as on one square centimetre of a mercury surface.

Measurements of the same surface were also made by the interference method[2].

Finally, the adsorption of palmitic acid was studied on large metallic granules with activated metallic surfaces, and when covered with coloured oxide films. The electrolytic method was also used with these granules. The results of adsorption measurements are near those of the interference method for slightly oxidized surfaces, but approach the order of magnitude of the electrolytic method for metallic surfaces.

A full account of the work will be published later.

RATIO OF PLANE AREA TO MEASURED AREA

Copper		Nickel	
Interference	Electrolytic	Interference	Electrolytic
1·52	10·4	1·33	9·0
2·26	25·3	2·00	18·2
2·40	26·8	2·70	22·4

ABSOLUTE GRANULE AREA 10^3 SQ. CM.

Copper		
Metal		
Interference	Electrolytic	Adsorption
4·5	55·2	30·7

Slightly oxidized (film *c.* 10^{-5} cm.)

Interference	Electrolytic	Adsorption
4·8	—	6·1

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[1] *Proc. Roy. Soc.*, A., **120**, 89 (1928), *et seq.*
[2] Constable, *Proc. Roy. Soc.*, A., **119**, 196 (1928).

Apparent Anomalous Isotopic Effect in Some Bands Associated with the Swan Bands

A number of weak bands have been noted in sources of carbon molecular spectra by Johnson[1] and by Fox and Herzberg[2]. Because of their association with carbon spectra, these bands were attributed to the carbon molecule, and several of the stronger ones (λλ 4770, 4836, 4911, 4997) tentatively identified as tail-bands of the Swan system. Measurements of the isotopic heads of the first three of these bands obtained from carbon enriched in the heavy isotope give some information concerning their nature and display an anomalously large isotopic shift.

The following positions of the heads of these bands were obtained from spectra of carbon containing 35 per cent ^{13}C, taken on a 21-ft. grating spectrograph in the first order. The source was an end-on quartz capillary discharge in argon containing a trace of methane, activated by a 3 kw. transformer.

^{12}C head	^{13}C head	Isotopic shift
4770·21 A.	4764·77 A.	
20,957·60 cm.$^{-1}$	20,981·52 cm.$^{-1}$	23·92 cm.$^{-1}$
4836·16	4827·57	
20,671·80	20,708·59	36·79
4910·95	4898·92	
20,356·99	20,406·98	49·99

The values 23·92 cm.$^{-1}$ and 36·79 cm.$^{-1}$ are thought to be accurate to less than 0·1 cm.$^{-1}$, while the value 49·99 cm.$^{-1}$ is not so accurate because the band λ 4911 is much weaker than the other two.

The fact that only two heads were present, even in low dispersion spectra of carbon which contained 50 per cent ^{13}C, is clear proof that the emitting molecule is not C–C, but contains only one carbon atom. The isotopic shift is very large, and can be explained only by the unreasonable assumptions of an infinitely heavy emitting molecule, so that the carbon has its maximum effect on the vibrational energy, combined with very large correction terms for the effects of anharmonicity and rotational shifts. The origin of the band system computed from the relative magnitudes of the isotopic shifts is near 21,500 cm.$^{-1}$, so that the 0,0 band is probably covered up by the 1,0 (λ 4737) Swan band.

From the occurrence of these bands in a wide variety of sources of carbon spectra, they must be due to carbon combined with a very persistent impurity; and from their occurrence in sources of high excitation, the emitting molecule should not be very complex.

These bands were noticed incidentally to measurement of the ^{13}C spin, and on account of pressure of other work, no further research on them can be done at this laboratory.

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[1] Johnson, R. C., *Phil. Trans. Roy. Soc.*, A, **226**, 157 (1926).
[2] Fox, J. G., and Herzberg, G., *Phys. Rev.*, **52**, 638 (1937).

Diffraction of Ultra-Short Radio Waves

Sommerfeld[1] has shown that in the study of the diffraction of electromagnetic waves at a sharp edge, account must be taken of the contribution to the diffracted field of the wave which is reflected at the edge. Because of the variation in boundary conditions at the edge for radiation linearly polarized in different planes, Sommerfeld deduced that the shadow cast by a sharp edge should be deepest for radiation polarized with the electric vector parallel to the edge.

Wien[2] and Jentzsch[3], amongst others, have observed this feature for waves in the visible spectrum. We have obtained the same result with ultra-short radio waves in the wave-band 2–3 metres. When such waves are propagated over hills with long ridge formations such as are found among the downs of south England, we have noted that the shadow behind the ridges is always appreciably deeper for horizontally polarized (electric vector horizontal) than for vertically polarized waves. Typical results obtained on a wave-length of 3 metres on Dunstable Downs are given in the accompanying table. For a fixed transmitter position situated on a plateau about 200 yards from the edge of a slope some 400 ft. in overall height, measurements of the vertical and horizontal electric field-strengths were made at a series of positions on the slope, the transmitting aerial being oriented according to the type of polarization under observation at the receiver.

Position	Field-strength in microvolts per metre		Ratio: vertical/horizontal fields	Remarks
	Vertical polarization	Horizontal polarization		
1	4500	4000	1·12	Gradual slope
2	2200	1800	1·22	
3	1000	800	1·25	
4	630	400	1·57	
5	320	180	1·78	
6	125	70	1·79	Steep slope
7	80	28	2·85	
8	36	16	2·25	
9	32	12	2·67	Gradual slope
10	40	14	2·85	
11	40	17	2·36	

It will be noted that near the top of the ridge (position 1) the vertical and horizontal electric field-strengths were approximately equal, but that on moving the receiver down the hill into the shadow, the vertical electric field increased relative to the horizontal electric field, and that finally, as the slope lessened, both fields increased slightly but the vertical electric field remained throughout greater than the horizontal field.

Similar results have been obtained on other hills devoid of trees. The presence of trees complicates the propagation characteristics of ultra-short radio waves, but it has been found that in the wave-band 2–3 metres, vertically polarized radiation appears, in general, to be the most efficient for conditions in which diffraction by hills is predominant.

This work forms part of the programme of the Radio Research Board, and this note is published by permission of the Department of Scientific and Industrial Research.

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[1] Sommerfeld, A., *Ann. Phys.*, **47**, 317–374 (1896).
[2] Wien, W., *Wied. Ann.*, **28**, 117–130 (1886).
[3] Jentzsch, F., *Ann. Phys.*, **84**, 292–312 (1927).

Isotope Effect in Potassium Dihydrogen Phosphate

WHEN the hydrogen in potassium dihydrogen phosphate (KH_2PO_4) is replaced by deuterium by repeated crystallization from warm 99·6 per cent heavy water (D_2O), the potassium phosphate separates in a different crystal structure. It can with some difficulty also be made to crystallize in the tetragonal form described by West[1], by adding a nucleus of KH_2PO_4 to a supersaturated solution of KD_2PO_4. When the new crystal form is powdered, it slowly reverts to the tetragonal form over a period of days.

As is being described elsewhere, a comparison of the tetragonal forms of KH_2PO_4 and KD_2PO_4 shows that the short hydrogen bonds (2·55 A.) are associated with a very considerable expansion of the lattice on substituting deuterium, thus showing similarity with the short hydrogen bonds in oxalic acid dihydrate and sodium bicarbonate[2].

The separation of acid potassium phosphate in a new crystal structure from heavy water is further evidence of the difference between hydrogen and deuterium bonds in crystals. So far as can be ascertained with the limited amount of material at present available, the new form is chemically identical with tetragonal KD_2PO_4 and has approximately the same density. From the X-ray data the crystals are monoclinic, with 8 molecules per unit cell, the axes being : $a = 7·37 \pm 0·01$ A. ; $b = 14·73 \pm 0·01$ A. ; $c = 7·17 \pm 0·01$ A. ; $\beta = 92·0°$.

Random errors are as given. Systematic errors probably do not exceed 1 per cent except for the a axis, for the determination of which only weak reflections were available. The crystals tend to elongate along the c axis, and prominent faces are (100), (010), and (110).

A detailed investigation of the new crystal structure is being attempted, since it promises to throw further light on the role of hydrogen bonds in crystals.

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[1] West, J., *Z. Krist.*, **74**, 306 (1930).
[2] Robertson, J. M., and Ubbelohde, A.R., *Proc. Roy. Soc.*, A, **170**, 222 (1939).

Specific Heat of Methane Under Pressure

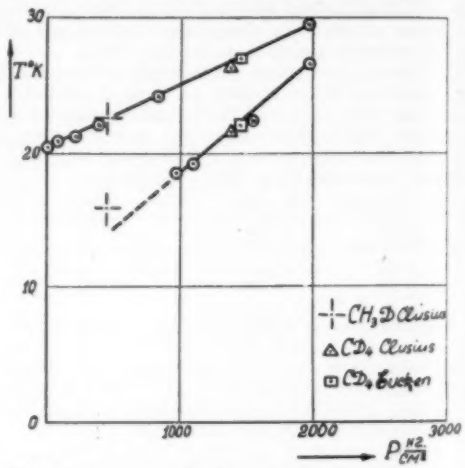
CLUSIUS[1] discovered the anomaly of the specific heat of solid methane at 20·4° K. ; Eucken, Heuse and others showed further that there was a case of the so-called λ-point. It appeared desirable to study the influence of the pressure of transformation at the λ-point.

Clusius and Perlick investigated the specific heat of solid methane under pressure up to 200 kgm./cm.². In our laboratory the measurements of the specific heat of methane were carried out from 12° K. to 30° K. at pressures up to 2,000 kgm./cm.², and the preliminary results are reported below.

The measurements were performed in a steel calorimeter, the specific heat of which was 20 per cent of that of solid methane at 18° K. The pressure was transmitted by helium. At a pressure of 1 kgm./cm.² the anomaly of specific heat occurred at 20·6° K. The maximum value measured was 200 cal./mol. (81 cal./mol. measured by Clusius), the breadth of the maximum at 10 cal./mol. was 0·4° (0·9° measured by Clusius). These data attest the high degree of purity of the methane investigated.

The measurements at all pressures were effected with one condensation.

The measurements of methane under pressure revealed the existence of two maxima of specific heat which shift with changing pressure. The accompanying diagram represents the dependence of the temperature T of these maxima on the pressure P. From the curves it follows that the low-temperature maximum which appears under pressure is shifted by the pressure faster than the normal maximum.



To all appearance methane under normal pressure has the second specific heat maximum at the temperature of liquid helium. The pressure shifts this maximum to the region of higher temperatures, where it is observed as the second maximum. The displacement of the maxima appears to depend on the increase of the density of the substance caused by pressure.

Clusius and his co-workers discovered two specific heat maxima : at 15·5° K. and 22·6° K. in CH_3D and 21·4° K. and 26° K. in CD_4. The introduction of one molecule of heavy hydrogen (D) is evidently equivalent to the influence of pressure upon ordinary methane.

The same conclusions were drawn by Eucken and his co-workers from their investigations of mixtures CH_4 and CD_4. Extrapolating, these authors come to the conclusion that CH_4 under a pressure of 1,200 kgm./cm.² must be equivalent to CD_4 at 1 kgm./cm.². Our measurements (see diagram) show the equivalency of CH_4 at 1,410 kgm./cm.² to the CD_4 of Eucken. The CD_4 of Clusius is equivalent to our CH_4 at 1,350 kgm./cm.². This slight difference is probably due to the difference in the purity.

An examination of these results confirms the view expressed above as to the analogy of the augmentation of density of CH_4 by pressure and the substitution of D for H in the molecule.

These results have been obtained in a calorimeter in which the helium transmitting the pressure was in direct contact with the methane.

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Kharkov.
June 20.

[1] Clusius, *Z. phys. Chem.*, **3**, 41 (1929).
[2] Eucken u. Bartholome, *Gott. Nachr.*, **2**, 51 (1936). Hense, *Z. phys. Chem.*, *A*, **147**, 282 (1930). Clusius u. Perlick, *Z. phys. Chem.*, B, **24**, 313 (1934). Clusius, *Physica*, **4**, 1105 (1937). Bartholome, Prikos, Eucken, *Z. phys. Chem.*, B, **39**, 371 (1938).

Colour of Celestine

SOME months ago, through the good offices of Mr. B. Topley, of Messrs. Albright and Wilson, Oldbury, we obtained several specimens of celestine from near Yate, Glos. Some were colourless, others tinged with blue, whilst a few were red. The blue crystals have been observed locally to occur lining channels or 'pipes' where water has bored through the massive mineral; the particular conditions favouring the red crystals are not apparently known.

The blue colour, to which celestine owes its name, is usually attributed to traces of vivianite, which possesses deep pigmentary power[1]. This, however, can scarcely explain the red colour.

Doelter[2] attributed the colours of celestine and numerous other minerals to the presence of colloidal inclusions, the degree of dispersion of which would determine the colour, whilst the concentration would determine the depth of that colour. He suggested, further, that the blue colour of celestine might be caused by colloidal sulphur produced by reduction of some of the sulphate.

Spectrograms of our specimens showed that whilst only minute traces of iron were present, the characteristic lines of gold were well defined in the red and blue specimens, but were scarcely perceptible in the white. The gold was extracted with aqua regia, reduced with phenyl hydrazine[3] and weighed on a sintered glass funnel using a microbalance. The iron was determined colorimetrically.

The results were as follows:

	Gold (p.p.m.)	Iron (p.p.m.)
Colourless crystals ..	nil*	19
Pale blue " ..	49	4
Deep red " ..	85	4

* Too small to extract.

It is noteworthy that the iron content was greatest in the colourless crystals, whilst the gold content rose with the depth of colour. When gently heated, the blue crystals became slightly pink, but the other crystals were unchanged.

We are inclined to the opinion, therefore, that the colours of our specimens are due to colloidal gold. We should like to examine specimens from other localities but are experiencing great difficulty in obtaining them; perhaps some readers of NATURE could help to obtain specimens.

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[1] Dana, "Descriptive Mineralogy", 906 (1914). Miers, "Mineralogy", 589 (1929).
[2] Doelter, "Die Farben der Mineralien" (1915).
[3] Using Pozzi-Escot's method of reduction (*Ann. Chim. Anal.*, **12**, 90 (1907)).

Vitamin B_1 and Acetate Oxidation by Bacteria

IT is now known[1] that vitamin B_1 may be a necessary factor for the growth of bacteria. Bacteria can, however, be grown with minimal amounts of vitamin B_1 and such bacteria (for example, *Staphylococcus aureus*) may show enhanced metabolic activities so far as the breakdown of pyruvic acid is concerned, when the vitamin is added to suspensions of the washed cells[2]. If the bacteria are grown on a medium containing adequate quantities of vitamin B_1, the subsequent addition of the vitamin to the washed cells does not affect their metabolic changes.

It is evident that a study of the action of vitamin B_1 on the chemical changes brought about by vitamin B_1-deficient bacteria may throw new light on the mechanism of action of this vitamin.

So far, attention has been mainly concerned with the effects of vitamin B_1 on pyruvic acid and lactic acid breakdown, following the work of Peters and his colleagues on the effects of this vitamin on the metabolism of avitaminous pigeon brain.

Werkman and his colleagues[3] have found that the growth and metabolism of propionic acid bacteria are affected by the presence of vitamin B_1.

We have found, using a washed suspension of propionic acid bacteria grown on a vitamin B_1-deficient medium, that the addition of the vitamin very markedly stimulates the oxidation of acetic acid.

Acetic acid is already known from the work of Stone, Wood and Werkman[4] to act as a hydrogen donator in the presence of the resting cells of propionic acid bacteria.

A typical result illustrating the action of vitamin B_1 on acetate oxidation is shown by the following figures, obtained with a suspension of bacteria grown on a vitamin B_1-deficient medium and incubated aerobically in a phosphate medium (in a Barcroft differential respiratory apparatus) at 37° for two hours:

Substance added to bacterial suspension	μl oxygen consumed	μl oxygen consumed, due to the acetate	μl acetate utilized
No addition	197	—	—
0·25 γ vitamin B_1 ..	245	—	—
0·01 *M* acetate ..	563	366	193
0·25 γ vitamin B_1 + 0·01 *M* acetate ..	1202	957	486

The following conclusions may be drawn. (1) In the presence of very small quantities of vitamin B_1 (for example, $0{\cdot}08 \times 10^{-3}$ mgm. per ml.) there is a very marked stimulation of the oxygen uptake in the presence of acetate, though not in the absence of the added substrate. This stimulation is not due to an increase in the number of bacteria during the course of the experiment as cell counts have shown. (2) The ratio of oxygen uptake to acetate utilized is approximately 2·0 and this ratio appears to be independent of the addition of vitamin B_1. The ratio of 2·0 would be expected if complete oxidation of acetate occurred according to the following equation

$$CH_3.COOH + 2O_2 = 2CO_2 + 2H_2O,$$

and estimations of carbon dioxide (or bicarbonate) formation have been consistent with this conclusion.

It would be a plausible view that the catalytic action of the vitamin is due to its accelerative effect on the oxidation of pyruvic acid possibly formed as an intermediate during the oxidation of acetic acid. Against this view, however, is the experimental fact that no pyruvic acid appears to accumulate when the acetate is oxidized by the bacteria in the absence of the added vitamin. Moreover, a ratio considerably less than 2·0 would be expected if acetate were oxidized in the absence of vitamin B_1 to an intermediate the further oxidation of which required the presence of the vitamin. Experiment has failed to show that traces of pyruvic acid block the aerobic oxidation of acetic acid. The inference would be that the acetic acid molecule itself, in the case at any rate of propionic acid bacteria, requires the presence of

vitamin B_1 to accomplish its aerobic oxidation. Whether this is the case with mammalian tissues is a matter shortly to be investigated.

Our experiments indicate that the catalytic agent is cocarboxylase (vitamin B_1 pyrophosphate) rather than vitamin B_1 itself (*cf.* Lipmann[5]). Silverman and Werkman[6] have recently shown that propionic acid bacteria are capable of synthesizing cocarboxylase from vitamin B_1.

More complete details of these and related experiments will be published in due course.

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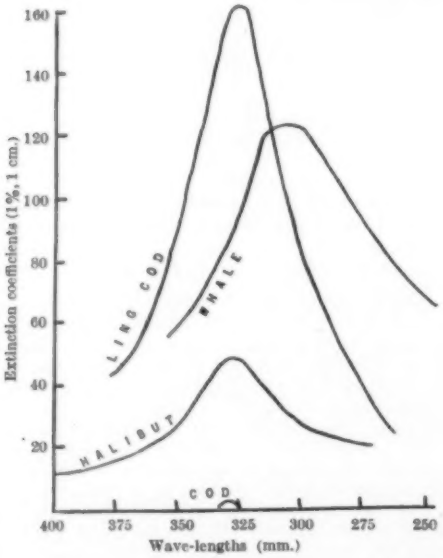
[1] Knight, *Biochem. J.*, **31**, 731, 966 (1937).
[2] Hills, *Biochem. J.*, **32**, 383 (1938).
[3] Wood, Anderson and Werkman, *J. Bact.*, **36**, 201 (1938). Silverman and Werkman, *Proc. Soc. Exp. Biol. Med.*, **38**, 823 (1938).
[4] Stone, Wood and Werkman, *Biochem. J.*, **30**, 624 (1936).
[5] Lipmann, *Enzymologia*, **4**, 65 (1937).
[6] Silverman and Werkman, *Enzymologia*, **5**, 385 (1939).

Vitamin A in Ling Cod Liver Oil

THE ling cod, *Ophiodon elongatus*, is an interesting fish because (1) it is neither a ling nor a cod; (2) it is found only in the north-eastern Pacific Ocean, and is one of the chief fish catches in British Columbia; and (3) it yields a liver oil rich in vitamin A[1].

Recently, in a routine examination of fish oils for whale oil adulteration, no published absorption curves for ling cod liver oil, or for Pacific whale oil, could be found. Such curves, together with average halibut and cod, are therefore presented in this note.



Ling cod liver oil is seen to have a typical absorption around 328 mμ (vitamin A), and in this case, to be much more potent than the sample of halibut liver oil.

Whale oil adulteration can easily be detected by the criteria of Drummond[2], though the curve for whale oil shown here is not quite identical with his curves.

We are very grateful to Dr. H. N. Brocklesby, of Prince Rupert, B.C., who observed the high vitamin A content of ling cod oil, for a sample of liver oil from carefully identified ling cod, and for the whale liver oil.

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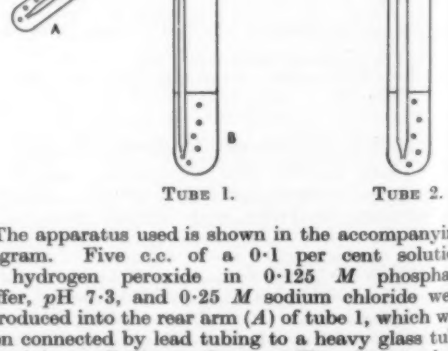
* Assisted from a grant to Prof. G. Hunter from the Associate Committee on Medical Research of the National Research Council, Canada.

[1] Van Wilby, G., "The Ling Cod", Biological Board of Canada, *Bull.* 54.
[2] Haines, R. T. M., and Drummond, J. C., *Analyst*, **63**, 335 (1938).

Decomposition of Hydrogen Peroxide by Catalase

IT has recently been stated[1], and it appears to be generally accepted, that the decomposition of hydrogen peroxide by catalase can only take place in the presence of molecular oxygen. It has been pointed out, however[2], that this phenomenon is difficult to understand, since it would be expected that such a strong oxidant as hydrogen peroxide would certainly react with the reduced form of the enzyme according to the scheme proposed[1]. As this point is of fundamental importance in relation to the mechanism of cellular oxidations in general, we have carried out some critical experiments to test the validity of the hypothesis. Our results have furnished rather unequivocal evidence that the hypothesis is untenable, and we would, therefore, like to report them here.



The apparatus used is shown in the accompanying diagram. Five c.c. of a 0·1 per cent solution of hydrogen peroxide in 0·125 *M* phosphate buffer, *p*H 7·3, and 0·25 *M* sodium chloride were introduced into the rear arm (*A*) of tube 1, which was then connected by lead tubing to a heavy glass tube containing palladium asbestos. The glass to lead connexions were sealed with de Khotinsky cement.

Into the front arm (*B*) of tube 1, and also into tube 2, were introduced 25 c.c. of a suspension of luminous bacteria (*Ph. Fischeri*) in phosphate buffer sodium chloride solution. The outlet of tube 1 was connected to the inlet of tube 2 by a heavy rubber tube. The outlet of the latter consisted of a capillary tube inserted in the rubber stopper as shown in the diagram. With this arrangement, hydrogen purified over heated palladium asbestos was passed in a continuous stream through the two arms of the first tube, and thence through the second. In less than two minutes after starting the flow of gas, the luminescence in both bacterial suspensions dimmed, which, according to Shapiro[3], would indicate that the oxygen tension was already less than 0·14 per cent. In another five minutes, the luminescence was extinguished, to the completely dark-adapted eye, in tube 1, while remaining faintly visible in tube 2, showing the presence of a minute amount of oxygen that may have been dissolved in, or diffused through, the rubber connexion between the two tubes. The fact that there was no luminescence in tube 1 proves that certainly less than a 10^{-5} atmosphere[4] of molecular oxygen was coming into that suspension from the rear arm containing the hydrogen peroxide solution. After another ten minutes of passing pure hydrogen through the vessels it may be safely assumed that tube 1 was completely free of molecular oxygen.

Tube 1 was then tilted, so that the hydrogen peroxide solution from arm (*A*) was mixed with the bacterial suspension in arm (*B*). There was an immediate and bright flash of luminescence, and a few seconds later the suspension in tube 2 also lighted up. While it may be possible that the luminescence in tube 1 resulted from a direct oxidation by hydrogen peroxide, it is quite certain, from the luminescence appearing in tube 2, that molecular oxygen was liberated when the hydrogen peroxide solution was brought into the suspension of bacteria, and it is equally certain that this reaction began under completely anærobic conditions.

To make certain that these results were due entirely to enzyme action, a portion of the same suspension was boiled for ten minutes and the experiment was repeated with boiled bacteria in tube 1. In this case tube 2 did not light up after the hydrogen peroxide was mixed with the boiled bacteria.

In connexion with the same experiments, it is interesting to note that the catalase activity of these bacteria, unlike the phenomenon of luminescence, is not dependent on intact, viable cells. Another portion of the same suspension was centrifuged and resuspended in distilled water, which immediately cytolyses the cells and extinguished both luminescence and respiration[5]. A drop of this suspension produced no growth on an agar slant, although the control, inoculated from the uncytolysed cells, produced abundant growth and bright luminescence.

Following the same procedure, hydrogen peroxide was again added in the absence of molecular oxygen. Tube 2 lighted up fully as well as it had when the living cells were employed in tube 1.

In conclusion, we would like to direct attention to the fairly well known, but frequently neglected, usefulness of luminous bacteria as a means of detecting the presence of molecular oxygen. May we suggest, also, that the simple method described in this letter might be profitably employed to investigate the activity of catalase not only in various species of bacteria but in enzyme preparations as well.

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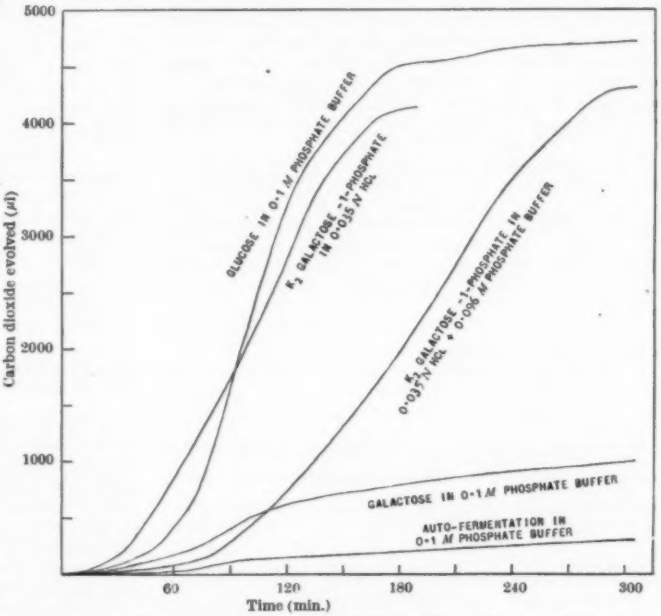
Galactose-1-Phosphoric Acid in Galactose Metabolism

THE synthesis of α (?)-galactose-1-phosphoric acid has provided a means of examining the constitution of the galactosephosphate accumulating in the liver during galactose assimilation[1]. Both natural and synthetic esters are non-reducing, very readily hydrolysed by acid, and resistant to alkaline hydrolysis. After removal of the reducing esters by alkaline hydrolysis, the mixture of phosphoric esters



100 MGM. DRIED GALACTOSE-ADAPTED *S. cerevisiæ* FROHBERG WERE USED TO FERMENT 1 MOL OF 0·1 *M* SUGAR OR ESTER SOLUTION (*p*H 6·5). READINGS WERE TAKEN AT INTERVALS OF 5–10 MINUTES.

isolated from the liver during galactose assimilation contained, apart from water of hydration, 29·6 per cent anhydrous barium galactose-1-phosphate, 3·1 per cent anhydrous glucose-1-phosphate, 2 per cent barium salt of an unidentified acid-labile ester, and 60 per cent barium salt of an acid-resistant ester. This mixture of barium salts had $[\alpha]_{5461} + 34{\cdot}4°$ and the barium salt of the acid-resistant ester $[\alpha]_{5461} - 3{\cdot}4°$. Cori, Colowick and Cori[3] found for anhydrous barium glucose-1-phosphate $[\alpha]_D + 75°$ which corresponds to $[\alpha]_{5461} + 89°$. By calculation from these values, natural barium galactose-1-phosphate would have $[\alpha]_{5461} + 114°$ while the corresponding value of the synthetic ester is $+ 110°$. Determined in a similar manner, the constant of hydrolysis of the natural ester in 0·25 *N* HCl at 25° would be $0{\cdot}87 \times 10^{-3}$ while that of the synthetic ester is $0{\cdot}89 \times 10^{-3}$. These findings, together with the earlier evidence, make it highly probable that the galactosephosphate present in the liver during galactose assimilation is identical with synthetic α(?)-galactose-1-phosphoric acid. An attempt is being made to crystallize the natural ester as the dipotassium salt.

The biological significance of these results is emphasized by the fact that synthetic galactose-1-phosphoric acid is fermented by dried galactose-adapted *S. cerevisiæ* Frohberg at approximately the same rate as is glucose, while galactose itself is fermented only very slowly (see graph). The relative quantities of carbon dioxide evolved during fermentation of glucose, of galactose-1-phosphoric acid, and of galactose, while subject to slight variation with change in concentration of inorganic phosphate, were 100, 94 and 15 respectively. It seems clear that in the fermentation of galactose, at least by the yeast preparation here employed, phosphorylation in position 1 is a necessary initial reaction proceeding at a relatively slow rate, while the phosphorylated product is fermented very rapidly.

The metabolism of galactose in the liver differs from fermentation by dried yeast in that galactose-1-phosphoric acid accumulates in the liver. The magnitude of this accumulation has not as yet been determined. There are obviously large losses in isolating the ester, which so far has been obtained in quantities equivalent to 5–12 mgm. of galactose per 100 gm. of liver.

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Blood Clearance of Free Chloral in Normal and Liver-damaged Dogs

FOLLOWING up the investigation on the urinary elimination of administered chloral hydrate in normal and liver-damaged dogs[1], we have made further observations on the blood clearance of free chloral under more or less identical experimental conditions. The data collected are rather interesting and appear to us to be worth recording, in as much as the results not only substantiate our previous conclusions drawn from urinary experiments, but also point the way to the development of a comparatively quicker and possibly more sensitive 'blood test' for gauging the detoxicating efficiency of the liver.

After the oral administration of chloral hydrate to dogs, in doses ranging from 100 mgm.–200 mgm./kgm., 1·0 c.c. samples of blood were taken from the hind limb veins, the first sample being collected when a fair degree of somnolence supervened in the experimental animals (usually between 35 min. and 50 min. after chloral hydrate). Subsequent samples were collected at one-hour intervals for six hours in order to ascertain the time at which the maximum concentration of free chloral was attained in the blood. Free chloral was estimated by the pyridine colour reaction of Friedman and Calderone[2]. Curiously enough, normal blood samples of dogs were found to give a faint pyridine colour reaction. Unless this is taken into account in expressing the final result, a higher figure is likely to be recorded. To eliminate this possible source of error, it was necessary to take an initial reading of the normal blood sample prior to the administration of chloral hydrate. Again, the pyridine colour tends to fade away within a very short time. For accurate readings, it is desirable to finish the colour measurements within a minute after the solution has been finally diluted with water. When these precautions are strictly attended to, fairly reliable results are obtained.

A typical set of experimental results obtained at the height of free chloral concentration in the blood about forty-five minutes after oral administration is presented in the table below.

	Dog No.	Maximum concentration of free chloral in blood (mgm. per cent)		
		Dose of chloral hydrate administered orally:		
		100 mgm./kgm.	150 mgm./kgm.	200 mgm./kgm.
Normal animals	1 (6·3 kgm.)	1·32	2·30	3·50
	4 (6·3 kgm.)	1·54	2·25	3·14
	6 (6·4 kgm.)	1·10	2·00	3·32
* Recent liver damage	1	2·00	3·00	4·56
	4	2·00	3·32	4·00
	6	1·83	3·00	5·00
* Long-standing liver damage	1	3·46	5·00	9·00
	4	3·64	4·85	7·50

* Recent liver damage caused by 4–5 administrations of CCl_4, and long standing liver damage caused by 15–20 administrations of CCl_4; each administration = 2 c.c./kgm.

It will be noticed that there is a significant increase in the blood concentration of free chloral in liver-damaged animals with as low a dose as 100 mgm./kgm. of chloral hydrate. In cases of chronic liver damage, a well-marked change in free chloral concentration is usually observed. In recently induced liver damage, the difference, though not as marked, is sufficiently significant to warrant the conclusion that a differential diagnosis may be possible.

We are indebted to Prof. R. N. Chopra for constant advice and guidance.

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Order of Magnitude of Morphogenetic Forces

The experimental analysis of embryonic development has been mainly concerned with elucidating the chemical mechanisms which cause different parts of the egg to develop into the organs and tissues of which the adult is composed. Much less is known about the physical forces which cause the changes in relative position which are such an important part of the developmental process. Preliminary measurements were therefore made of some of the physical magnitudes associated with the process of gastrulation in the eggs of the newt *Triton alpestris*.

In the first set of experiments, small steel balls were placed in the blastocœl cavity of young gastrulæ, and subjected to the magnetic field produced by one pole of a long bar magnet. The pole and the egg were gradually brought closer together until the ball was pulled through the blastocœl roof. Two sets of experiments were made: in the first, with a ball 0·216 mm. in diameter, breakage of the roof occurred at distances of 0·83, 2·0, 1·83, 1·0, 1·33, 1·0, 1·0 mm., average 1·36; in the second, with a ball 0·3 mm. in diameter, breakage occurred at 1·5, 1·5, 1·83, 1·5, 1·33, 2·0, 1·83, average 1·66. Converting these measurements into mgm. of pressure per sq. mm. of the hemispherical surface of the ball in contact with the roof, the averages for the two series are 7·02 and 7·29 mgm./mm.^{2}.

In another series of experiments, balls were placed among the gastrulating cells in such a way that the applied magnetic force was opposed to their normal movements; the eggs were placed at various distances from the magnet, and it was noted whether any movement of the balls took place over a period of about eight hours. For balls of diameter about 0·083 mm. placed in the mesoderm, movement occurred at distances of 9·5, 8·0, 6·83 (?), 6·66, 6·33, 6·0, 5·83 mm., no movement at 7·83, 5·5, 5·3, 5·16, 4·66, 4·0. For similar balls in the endoderm, movement occurred at 8·5, 5·83, not at 7·16, 6·0, 5·5, 5·0, 4·66, 3·83, 3·66, 3·33 mm. If we take for both tissues the limit at which movement could occur at about 5·66 mm., the maximum force exerted by the gastrulating tissues is equivalent to 0·34 mgm./mm.^{2} of the hemispherical surface.

These measurements are of a preliminary nature, and no great accuracy is claimed for them. It is interesting to note that the force exerted by the gastrulating cells is much less than the breaking strain of the tissue. Before any attempt can be made to interpret this it will be necessary to know something of the rigidity, and the viscosity at various rates of flow, of the tissues concerned.

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Points from Foregoing Letters

The quantitative discrepancy between the observed and the theoretical ratio of the life-time of the free meson to that of a light radioactive element can be removed, according to C. Møller, L. Rosenfeld and S. Rozental, by combining a vector and a pseudoscalar field for the meson in the calculations.

D. Dervichian finds that when a protein is dissolved in water to which a trace of a capillary active substance able to lower the surface tension is added, the protein can be spread on the surface of an aqueous solution. He also discusses the meaning of 'spreading number'.

C. H. Townes discusses the presence, in the spectrum of carbon containing ^{13}C, of bands, hitherto ascribed to the carbon molecule, which he believes are due to a persistent impurity of complex molecular structure.

It has been found by J. S. McPetrie and J. A. Saxton that in the ultra-short radio wave-band 2–3 metres the attenuation of received field-strength for positions within the shadow of hills is most pronounced for radiation polarized with the electric vector horizontal.

A. R. Ubbelohde and Miss I. Woodward find that when deuterium replaces hydrogen in potassium dihydrogen phosphate, this substance crystallizes in a new structure, thus giving further evidence of the difference between hydrogen and deuterium bonds in crystals.

O. N. Trapeznikowa and G. A. Miljutin find two maxima, which shift with pressure, in the specific heat of methane between 12° K. and 30° K., at pressures up to 2000 kgm./cm.^{2}. The effect of substituting deuterium for hydrogen in methane has a similar effect to increasing the pressure on ordinary methane.

Specimens of blue and red celestine from Yate, Glos., have been examined by J. N. Friend and J. P. Allchin, who attribute the colour to colloidal gold.

J. H. Quastel and D. M. Webley find that the oxidation of acetic acid by suspensions of propionic acid bacteria grown on a vitamin B_1-deficient medium is greatly accelerated by the addition of small quantities of the vitamin, complete oxidation of the acetic acid taking place.

The statement has recently been made that the decomposition of hydrogen peroxide by catalase can only take place in the presence of molecular oxygen. F. H. Johnson and K. L. van Schouwenburg describe an experiment in which decomposition occurred under completely anærobic conditions.

H. W. Kosterlitz discusses the role of galactose-1-phosphoric acid as an intermediary in the metabolism of galactose in liver and in yeast. This ester is fermented by dried galactose-adapted *S. cerevisiæ* Frohberg about six times as rapidly as is galactose. There is an appreciable accumulation of the ester in the liver during galactose assimilation.

B. Mukerji and R. Ghose report that in recently induced and long-standing liver damage, a significant increase in free chloral concentration of blood occurs within an hour of the oral administration of chloral hydrate to dogs. Blood clearance of free chloral may, therefore, be employed as a test for detoxication function of the liver.

C. H. Waddington describes measurements of morphogenetic forces made by means of steel balls embedded in gastrulæ of *Triton alpestris* and then subjected to magnetic forces. The breaking strain of the blastocœl roof was of the order of 7·15 mgm. per sq. mm. of the hemispherical surface of the ball in contact with the tissues. Gastrulating mesoderm and endoderm could move the balls against a maximum force of 0·34 mgm./sq. mm.

RESEARCH ITEMS

Ethnography of the Washo of Nevada, U.S.A.

Robert H. Lowie, during a stay of several weeks at Minden, Nevada, and at Coleville, California, in 1926, was able to supplement the somewhat exiguous technical information available concerning the Washo. This is an isolated stock or an aberrant Hokan group ranged about Lake Tahoe in westernmost Nevada and easternmost California (*Univ. California Pub. Amer. Ethnol. and Archæol.*, **36**, 5; 1939). Kroeber sets their number in 1770 as possibly 1,500, where more recent figures approximate 300. Their settlements were minute, their huts usually being from two to four. The chief had nothing to do with fighting enemies or adjusting quarrels within the tribe. His sole function was to arrange dances and other gatherings, where he would exhort the Washo to be good. Special headmen led in hunting jack rabbits, deer and antelope respectively. The antelope headman dreamed the right to office, the two others were purely secular leaders, the rabbit chief being chosen by the people. Property rights were maintained for clumps of pine nut trees, patches being marked off by lines of rocks. While brothers never quarrelled over pine nut privileges, trespass by a stranger was resented. Acorns were not a staple of diet, though the Washo made a dish of them. The pine nuts were gathered by men and women co-operatively. When dried, the nuts kept for about a year. Along the Walker River, the Washo constructed many 'fish houses'. Trout were speared and fish were also taken in nets or clubbed to death. Antelope, deer and jack rabbits were hunted communally. Other species of animal added to the food supply; porcupine, grasshoppers and locusts were eaten. The shamans became such through dreams, but not every dream was interpreted as a transfer of supernatural power, even though it might be of an uncanny character.

Sacred Twinned Vessels

M. D. W. Jeffreys describes and figures in *Man* of September a collection of sacred twinned vessels, now in the Wellcome Historical Medical Museum, London, which he obtained in 1930 in the markets of the native towns of Akwa and Aguleri, Nigeria—strongholds of the Umundri culture in the Onitsha Province. Design and decoration of one of the vessels suggest that the pottery is based on a wood technique. From the religious use to which they are put the vessels may be regarded as a unit combining the Patten and the Chalice. In them is placed the sacrificial food and oblation of wine when offered to a sky god *Chuku*, to *Alushi*, and to the ancestral spirits *Ndichie*. The vessels are not common, and with the increasing spread of Christianity are now seldom made. Similar twin vessels have been reported from Egypt. It is possible there is a connexion between the use of sacred twin vessels and the derivation of the word *graal* or *grail*. One suggestion is that *graal* is an abbreviation of *gradalis*—*grad*-'step' or 'division', *alis*-'food', that is, a combined or stepped vessel for keeping separate the sacrificial offerings. Bread and wine have been through the ages the offerings to the gods and ancestors and it is reasonable to assume special vessels to prepare and carry them, combining the two into a single unit. The use of vessels having separate compartments for different kinds of offerings appears in the Greek *kernos*, several small cups or jars joined together. It was used in the Eleusinian Mysteries to carry first-fruits, and a similar vessel of metal is in use in the Orthodox Greek Church to-day.

Arthritis in Wild Mammals

Herbert Fox, of Pennsylvania, in the course of examination of 1,700 wild mammals has observed changes in the joints which correspond with chronic arthritis in man (*Trans. Amer. Phil. Soc.*, N.S., **31**, 75; 1939). This applies to truly wild animals as well as to menagerie specimens. The cases described seem to indicate that there is no apparent relationship between the incidence of arthritis and the systematic position, geographical distribution, habits or habitat of the mammals involved. On the whole the most conspicuous lesions occur among anthropoid apes, baboons, Felidæ, Hyænidæ, Ursidæ, Cervidæ and a few others; whereas a number of groups, such as Canidæ, Rodentia and Chiroptera, seem to be free from the disease, at any rate so far as shown by the material examined. Prof. Fox makes an interesting suggestion, that the one character which separates arthritic mammals from non-arthritics is body size. This may be compounded of a large body upon slender supports (as in Bovidæ), or stockily built body upon stouter supports (as in Felidæ). Where the greatest stabilization of the spinal column is demanded for the animal's locomotion there the greatest degree of spondylitis arises, and the localization of lesions in the fore-limbs of carnivorous mammals and the hind-limbs of herbivores may be associated with jolt-shock and locomotive power.

Deep-Sea Fishes of Bermuda

The importance of an account of the Bermudan deep-sea fishes of the family Melanostomiatidæ, by Walter Beebe and Jocelyn Crane, can be gauged from the size of the collection described. Intensive collecting in a limited area eight miles in diameter and a mile deep yielded 250 specimens belonging to 10 genera and 32 species, or 62 per cent of all known genera and at least a third of the species taken in all seas (*Zoologica*, **24**, 65; 1939). The collecting was noteworthy also because extensive use was made of the bathysphere for recording movements and behaviour, and ten individuals, representing five species, were examined alive and their luminescence and behaviour noted, while more than 100 freshly caught specimens were used for the recording of colour notes and sketches. Hitherto only eight specimens in the entire family had been studied when freshly caught or recently preserved. As with most families of Bermudan deep-sea fish, the depths at which these were taken were greater than the average in other regions, practically none except very young individuals having been taken above 500 fathoms, although they were seen above that level from the bathysphere. The description of the collection runs to 174 pages and contains many striking figures of these deep-sea forms and their remarkable barbels.

Hymenopterous Parasites of Hover Flies

The hover flies or Syrphidæ constitute one of the largest families of the Diptera. In their larval stages many of them are highly beneficial to man since they prey upon aphides and thereby destroy very large numbers of the latter. They are, perhaps, the most important of all the natural enemies of these pests. The usefulness of syrphid larvæ is apparently counteracted to a considerable extent by species of hymenopterous parasites. Our knowledge of the structure and biology of such parasites is extremely meagre and their earlier stages have scarcely been observed at all. An attempt towards filling this hiatus in entomological knowledge is made by M. Kamal who, under the title of "Biological Studies on some Hymenopterous Parasites of Aphidophagous Syrphidæ", contributes an article as Bulletin 207 (Entom. Section) Technical and Scientific Service, Egyptian Ministry of Agriculture. The investigations embodied in this paper were carried out at Riverside (Calif.) under Prof. H. S. Smith, and they serve as a beginning towards a better understanding of the subject. A distinct drawback is the absence of any date indicating when the Bulletin was published.

Pelargoniums

The Pelargonium, which goes too often under the erroneous horticultural pseudonym of Geranium, is a potent and ubiquitous contributor to garden beauty. It is usual to think in terms of one or two species only of this genus, but Sir Arthur W. Hill (*J. Roy. Hort. Soc.*, **64**, Pt. 8, August 1939) has recently described a larger number of the 250 species which it actually contains. South Africa is the home of the genus, and more than 200 species grow there. The Dutch were the first to bring over Pelargoniums of horticultural value, and *P. triste* was apparently the first kind to appear in Great Britain, in the year 1632. By 1703, a considerable number of species was in cultivation, and the favourite *P. zonale* was produced by cross-breeding in 1710. Sir Arthur's paper is designed to portray the horticultural possibilities of the genus; he deals with variety in leaf and flower form, outlines the tuberous species, and mentions such kinds as *P. tetragonum* with fleshy stem and cactus-like flower, and *P. crithmifolium* with fleshy leaves.

Crustal Structure of California

Using data obtained by reading seismograms for sixteen near earthquakes and one blast, P. Byerly has determined the structure of the crust of the earth in California and the speeds of the primary and secondary waves in the several layers of the crust (*Bull. Seismol. Soc. Amer.*, 29, No. 3, July 1939, pp. 427–462). The records used were chiefly from Wood-Anderson and Benioff seismographs with a drum-rate of 60 mm. per min. and they were read to the nearest 10^{-1} second of time. The estimate of the dimensions of the crust chiefly rests on the accurate determination of the depth of focus of the Berkeley earthquake of March 8, 1937. These dimensions turn out to be 9 km. of granite overlying a layer 23 km. thick of intermediate material, which itself overlies the mantle. Data obtained for shocks with epicentres to the south of Berkeley were found not to fit this structure, but successfully did so when it was assumed that the granitic layer thickened towards the south. In all the earthquakes considered there was a lag of P_n as it passed under the Sierra Nevada, a fact which had been noticed previously. A reconsideration of the P_n data of the Nevada earthquake of December 20, 1932, together with all the other data, suggests that the root of the mountain mass projects into the mantle beneath the surface layers by an amount between 6 km. and 41 km. The velocities of the P and S waves in the various layers were found to be (*a*) in the surface layer $P = 5{\cdot}61 \pm 0{\cdot}05$ km./sec., $S = 3{\cdot}26 \pm 0{\cdot}09$ km./sec. and there is a suggestion that these may start from different foci; (*b*) in the intermediate layer $P = 6{\cdot}72 \pm 0{\cdot}02$ km./sec. and $S = 7{\cdot}24 \pm 0{\cdot}04$ km./sec., though only the former was used for the determination of the structure: (*c*) in the mantle $P_n = 8{\cdot}02 \pm 0{\cdot}05$ km./sec.

Age of Meteorites

F. A. Paneth has issued an important paper with this title which describes the methods for determining the age of meteorites and the results obtained (*Occasional Notes Roy. Astro. Soc.*, No. 5; 1939). The most satisfactory formula is derived from the following simple principles: let U and Th be the grams of uranium and thorium present in a sample of a meteorite, and let He be the number of cubic centimetres of helium which have originated from these two radio-elements; then the age in years is

$$\frac{He}{1{\cdot}14\,U + 0{\cdot}29\,Th}\,10^7.$$

At one time it was believed that the age-values determined by this method were on the low side, owing to the escape of helium. As Paneth points out, however, temperatures up to 1000° cannot drive out more than about 5 per cent of the helium contained in an iron meteorite, and as only the outermost portion is heated during the flight through the atmosphere, the method is satisfactory for iron meteorites. This remark does not apply to stone meteorites; the stone meteorite Pultusk lost practically all its helium content after 3 hours at a temperature of 800°. Table ii shows the maximum age in millions of years of thirty meteorites. This varies from 2,800 in the cases of Thunda and Mount Ayliff to only 100 with Bethany, Goamus, and Toluca. On the basis of the assumption as to the solubility of thorium in iron, Paneth and his colleagues were of opinion that the real values might be 10–20 per cent lower; but this is an under-estimate. They developed a method for the determination of the thorium content of iron meteorites, preliminary figures for three of which are given, and, though improvements can still be made, they are confident that its quantity in meteoritic iron can be greater than was suspected. The above equation shows that this will diminish the age, and in the case of Bethany, Goamus, the figures are 30 million years instead of 100 million years. The result of the research shows that no meteorites exist with ages greater than that of the earth—a fact which supports the view that the meteorites originated within the solar system. Nevertheless, the low age found seems to give weight to the short time-scale of the universe, that is, that the whole universe is of no greater age than the earth. It seems fairly certain that iron meteorites assumed the solid state at different times, and further research will probably reveal important relations.

THE SIXTH PACIFIC SCIENCE CONGRESS

THE immense area of the Pacific Basin comprises what is perhaps the most fascinating region of the globe. It is bounded on the east, on the north and, as far south as the equator, on the west by volcanic regions indicative of great geological instability. It includes open stretches of sea hundreds of thousands of square miles in extent and contains more than twenty thousand islands, some of them rocky, others volcanic and others again of coral origin. These islands have a distinctive and in many respects a unique fauna and flora. They are populated by most interesting native races, Polynesians, Melanesians and Micronesians, who, coming originally from south-east Asia, settled these widely scattered islands by the most remarkable of all human migrations. There they evolved a civilization which evoked the amazement of those early European navigators who, however unwittingly in many cases, sowed the first seeds of its subsequent rapid decay.

Despite the great pioneer voyages of Spanish, Dutch, British, French and Russian navigators and of New England whalers in the seventeenth and eighteenth centuries and of scientific explorations such as those of the *Challenger* and of the United States exploring expedition under Wilkes in the nineteenth century, the area covered by scientific and commercial surveys up to the beginning of the present century has been aptly described as no more than "a plough furrow in a twenty acre field". To quote from the introductory speech to the Sixth Pacific Congress of Prof. Herbert E. Gregory, former director of the Bernice P. Bishop Museum, Honolulu, and the greatest individual force behind modern scientific study of the Pacific: "The material and records amassed by such long time undertakings as the Wilkes and the *Challenger* expeditions and during the first two decades of the present century by local surveys under the auspices of scientific institutions in England, Scandinavia, Australia, Netherlands Indies, Japan, Canada and the United States is large in bulk and variety. But its study reveals far more questions than answers. It shows that the Pacific is fairly bristling with problems in geography, geology, botany, zoology and anthropology and that the observations recorded here and there in a region that comprises more than a third of the earth's surface are inadequate for comparative studies of the earth's physical features and of the origin, migrations and environment of living forms on the land and in the sea; and that until further knowledge has been gained many of the stories that science has to tell must be incomplete".

Co-ordinated scientific study of the Pacific was discussed at the meeting of the British Association in Australia in 1914 and afterwards in the United States. But it was not until 1920 that, largely owing to the initiative of Prof. Gregory, the first Pacific Science Congress met at Honolulu. This took the form of an informal gathering of some sixty carefully selected delegates from the United States, Canada, Hawaii, the Philippines, the Netherlands Indies, Japan, China, Australia, New Zealand and Samoa. It was realized that a central organization and planned expeditions were impracticable owing to lack of funds, but that a purely volunteer organization could play a great part in the furtherance of research in the Pacific if each unit, while perfecting its own programme, subscribed to a common programme and kept in close touch with associated organizations in other countries bordering the Pacific. While official delegates have been sent by interested Governments to subsequent congresses, these have always consisted essentially of individuals interested in various aspects of research in the Pacific area. This emphasis on the individual rather than on the State and on subjects of general scientific interest, to the exclusion of anything likely to have a political bearing has been the key to the subsequent outstanding success of the Pacific Science Association.

The second Pacific Science Congress was held in Australia in 1923, the third in Japan in 1926, the fourth at Java in 1929 and the fifth in British Columbia in 1933. It was there agreed that the sixth congress should not meet in North America, and the possibility of a congress at Fiji was discussed. This later proved impracticable, while international difficulties steadily increased so that the maximum period of five years between successive congresses was passed without another meeting being arranged. But representations made at Washington to the National Research Council of the United States most fortunately prevented what, as later events have shown, would almost certainly have been a complete break in the continuity of these congresses.

Under the auspices of the National Research Council a sixth Pacific Science Congress was organized and held in and around San Francisco during July 24–August 12, 1939. The meetings were held at Berkeley, Stanford and San Francisco, the University of California and Stanford University acting as joint hosts, and the Golden Gate International Exposition co-operating with them through its Department of the Pacific Area. Prof. Ross G. Harrison was president, and Prof. Roy E. Clausen, secretary-general, of the Congress.

The courageous optimism of these responsible for the organization of the Congress was abundantly justified by the presence of some five hundred delegates, including representatives from Australia, Canada, China, Columbia, France, Great Britain, Hawaii, Hong Kong, Japan, the Netherlands and the Netherlands Indies, New Zealand, the Philippines, Siam, Sweden, the U.S.S.R., and the United States. The discussions covered a wide field, as may be indicated by the nature of the sections and subsections into which the Congress was divided.

Section 1, Geophysics and Geology, dealt with the structure and dynamics of the Pacific basin; section 2, Oceanography and Marine Biology, including Fisheries, with the properties, dynamics and life of the Pacific. Pacific climates formed the subject-matter of section 3, which discussed past climates and also present climates under the two headings of meteorology and climatology. Section 4, Anthropology, dealt with man and culture in the Pacific region and with the objectives and results of the study of these cultures. Section 5 was concerned with the terrestrial faunas of the Pacific islands and bordering countries, and was especially concerned with systematic and economic entomology, including

biological control of insect pests, and with medical entomology. General botany and plant diseases of the Pacific region constituted the two subsections of section 6. Section 7 consisted of public health and nutrition, and was divided into subsections dealing with the geography and epidemiology of the communicable diseases of the Pacific region, with health hazards arising from transport, occupation and agricultural practices, with nutritional problems and finally with education in matters of health. Section 8 dealt with the characteristics, utilization and conservation of the soils in the countries of the Pacific.

All who are in any way interested in the manifold scientific problems of the Pacific owe a debt of gratitude to the National Research Council of the United States and to all who pressed, against considerable and not unnatural opposition, for the holding of this Congress. There must be many of the foreign delegates who now feel, with the writer, that this meeting, attended by so many races and nationalities united in the prosecution of disinterested scientific research, will be during the darkness which looms ahead both a memory of a happier past and a foretaste of a more enlightened future. The Congress broke up in the expectation of a seventh Congress to be held in the Philippines in 1943. That the future course of world history makes this possible may well be the wish of every civilized human being.

LOWER PERMIAN INSECTS OF KANSAS

F. M. CARPENTER has recently discussed numerous specimens of fossil insects obtained in 1935 from the Elmo limestone (Kansas), of Lower Permian age (*Proc. Amer. Acad. Arts and Sci.*, **73**, 29–70; 1939). More than 8,000 specimens from this formation are now in the collections of the Harvard Museum of Comparative Zoology.

The results of the 1935 collection exceed all others in the number of complete, or nearly complete, specimens that were disclosed. Some of the most interesting fossils obtained are members of the group which Tillyard named the Protohymenoptera, and now regarded as belonging to the Megasecoptera. Thus, in *Permohymen*, the male genitalia are well preserved and are seen to be composed of paired penes with two-segmented claspers which are evidently homologous with the styli of may-flies. Regarding *Asthenohymen dunbari*, 32 specimens were found, and, of these, four present enough of the body structure to allow, for the first time, a complete reconstruction of the insect to be made and the differences between the fore and hind wings to be ascertained. In one example the ovipositor is well preserved.

The Protodonata that were collected on the 1935 expedition proved to be unusually interesting. In the first place the discovery of *Meganeuropsis permiana* gen. et. sp. nov. from the Permian of Elmo constitutes the first example of a Meganeurine occurring in the New World and also in rocks of Permian date. Dr. Carpenter discusses the affinities of the family Meganeuridæ, and does not accept Martynov's contention that they should be placed in the order Odonata as true dragonflies: he concludes that there is no justification for their separation from the Protodonata until it is proved that the Meganeuridæ had a phylogenetic origin different from that of the other families of that order.

The author then passes on to deal with the Homoptera. Altogether twenty-six specimens belonging to this group were collected. While none of the species is new, the material adds to knowledge of the body structure and the hind wings of the Homoptera. In *Permoscytina kansasensis* Till. the single specimen obtained during 1935 shows a long process extending straight back from the end of the abdomen: being 9 mm. long, it exceeds the length of the combined thorax and abdomen. Dr. Carpenter concludes that it is not an ovipositor but rather of the nature of a respiratory tube such as is found in water bugs of the recent family Nepidæ. This contention presupposes that the insect was aquatic, but there appears to be no indication of any modification of the rest of the body from an aquatic environment, a feature shown in the recent family Nepidæ.

The remainder of the paper deals with the Psocoptera, Protelytroptera and Protoperlaria.

A. D. I.

INVENTIONS AND PATENTS IN GREAT BRITAIN*

THE fifty-sixth report of the Comptroller-General of Patents, Designs and Trade Marks for 1938, records a further increase in the number of patents, applications having increased from 36,266 in 1937 to 37,973 in 1938, with increases in the number of provisional and complete specifications from 21,745 and 22,215, respectively, to 26,696 and 23,098. In regard to the trend of inventions, the synthetic production of artificial wool and rubber, the latter by the polymerization of diolefines and halogenated diolefines, continues to be prominent. New developments in the very active field of synthetic resins are the use of polyamide resins for making artificial yarn and the use of resins in water purification by ionic exchange. Antioxidants or stabilizers for rubber, oils, fats, soaps, aldehydes and light-sensitive substances are much in evidence. Applications relating to azo and vat dyes decreased in number, but the development of long-chain polymethine dyes for use as photographic sensitizers is actively sustained.

* Patents, Designs and Trade Marks. Fifty-sixth Report of the Comptroller-General of Patents, Designs and Trade Marks, with Appendices, for the Year 1938. Pp. 26. (London: H.M. Stationery Office, 1939.) 6d. net.

The manufacture of glass fibres of extreme fineness and the use of short-path high-vacuum distillation for the concentration of vitamins have received attention, as well as directional wireless systems in relation to the navigation and blind landing of aircraft. Notable developments with electron microscopes relates to the magnetic lens systems, the arrangements for inserting the object under examination and the use of a fine scanning beam in place of a fixed electron beam. Methods of giving air-raid signals over electric power networks are being explored, and another interesting development is concerned with the speedy testing of watches, for accurate time-keeping, by electric means. A notable feature has been the production of vehicle bodies and aircraft fuselages and girders from synthetic resins. Mechanical remote-control systems are being devised to free the floors of motor-vehicles from obstruction by control levers, while another field of activity has been in gyroscopic instruments for indicating the course and altitude of flight of aircraft and in the automatic supervision, by means of magnetic compasses, of course-indicating gyroscopes so as to eliminate wandering.

Applications for designs and registered designs both decreased in number compared with 1937, but registered trade marks increased.

GEOGRAPHICAL DISTRIBUTION OF THE COWRIES

IN the study of the geographical distribution of the littoral marine fauna, the Mollusca claim special attention, since the activities of collectors have provided far more abundant data regarding them than are available for any other group of marine animals. More especially is this the case with such groups as the large and handsome tropical cowries and cones which have been favourites of the dilettanti for two centuries at least. It is true that a great deal of the older work on them is without any scientific value; endless lists of 'varietal' names have been given to individual abnormalities, environmental modifications, and stages of growth, while localities have been vaguely or incorrectly recorded. Nevertheless, it has long been obvious that a great amount of valuable material was awaiting scrutiny by modern methods.

This has now been done for the cowries by Dr. F. A. Schilder and Dr. M. Schilder in a "Prodrome of a Monograph on living Cypræidæ" (*Proc. Malacol. Soc.*, **23**, Pts. 3 and 4; 1938–39), in which a revision of the whole family is given, together with a detailed analysis of the distribution of the species and subspecies composing it. The material studied by the authors comprised more than 60,000 shells, in some eighty public and private collections in Europe. They recognize 165 species, nearly all of which are further subdivided, each into two or more geographical races or sub-races. The races and sub-races are treated together for nomenclatorial purposes as sub-species, and they "can be recognized at least by the sum of several variable characters of the adult shells and by the fact that each race has usually its own centre of distribution where it is relatively more frequent than at the periphery". The species and races are further grouped into units of higher order designated 'superspecies', which are equivalent to the *Rassenkreise* of Rensch, and are defined as "the sum of the allied species and sub-species inhabiting a mostly continuous region and geographically separate from each other".

The authors' conception of a super-species is not very easy to grasp, and it must be said that their exposition is not everywhere a model of clarity. For example, the statement that "in some genera several evidently allied species inhabit the same region; they must each be treated as different superspecies" would seem difficult to reconcile with the definition just quoted. It can be so reconciled, but only to leave one in doubt whether the idea of super-species is worth very much after all.

Nevertheless, the monograph deserves careful study as perhaps the first attempt to apply on a large scale to marine animals those methods of geographical delimitation of races which have hitherto been applied almost exclusively to terrestrial and freshwater organisms.

W. T. C.

THE BREEDING OF OYSTERS*

EXPERIMENTS on the breeding of oysters in large concrete tanks have been in progress at Conway, North Wales, since 1919. The ultimate aim of the work has been to provide a simple and efficient means of procuring the settlement of large crops of oysters in tanks, in the belief that such a method would prove of value to the oyster growers in replenishing their stocks. Mr. Cole has already explained his methods in two previous papers: "Experiments in the Breeding of Oysters (*Ostrea edulis*) in Tanks, with Special Reference to the Food of the Larva and the Spat" (Fishery Investigations, Series II, **15**, No. 4, 1936) and "A System of Oyster Culture" (*J. du Conseil*, **13**, No. 2, 1938). It is now believed that this aim has been realized and that spatfalls of commercial magnitude may be obtained regularly in the Conway tanks.

This work is of great interest and importance and based upon years of labour, early experiments having been made at Conway by Dr. R. W. Dodgson and Mr. H. P. Sherwood.

The main plan is to enrich one large tank gradually by the addition of finely ground crab meat,

* Fishery Investigations. Series II, **16**, No. 4. "Further Experiments in the Breeding of Oysters (*Ostrea edulis*) in Tanks", by H. A. Cole. Ministry of Agriculture and Fisheries. (London: H.M. Stationery Office, 1939.)

whilst the other is left untreated. Smaller tanks are also used for breeding. The purpose of the organic enrichment is to bring about the multiplication of minute flagellates which we now know to be the food of the free-swimming larval oyster. Oysters placed in the tanks liberate their shelled larvæ which in both treated and untreated tanks settle as spat, but in the enriched tank the number settling is found to be much greater. Very heavy spatfalls were obtained in the tanks on limed tiles in both 1937 and 1938, and the commercial possibilities of this method of obtaining the settlement are clearly demonstrated. In both these years there was a nannoplankton consisting almost entirely of very small flagellates, and the ability of the oyster larvæ to feed on such flagellates has been confirmed by laboratory feeding experiments, which have also shown that they can not utilize non-motile green and blue-green algæ during the free-swimming period. The higher concentration of flagellates in the treated tanks is favourable to rapid growth and settlement of the larvæ.

The length of the larval free-swimming period under tank conditions varies between seven and fourteen days, ten days being the average. Between a temperature of 16° and 22° C. the length of the free-swimming period does not vary more than a day or two and, after liberation, food supply rather than temperature appears to be the critical factor. Temperature, however, affects the spawning, but the relation under tank conditions is complex. Spawning does not usually occur below 17° C. A sudden rise of 2°–3° C. around a temperature of 16°–17° C. is likely to produce spawning among ripe females. Sustained high temperatures (19°–20°) may have the same result.

It is interesting that some of the experimental larvæ reached an enormous size (0·35 mm.) before attachment, the usual size being 0·18–0·20 mm. on liberation and 0·28–0·31 mm. on settling.

The bulk of the limed tiles on which the spat has settled is removed to shallow tanks filled with water from the estuary. In this way they get the much larger amount of food necessary in the fixed stage. Later the tiles are planted out in the Menai Straits, where the oysters grow rapidly. Most of the spat planted in August 1938 was only three weeks old, but it is believed that such early planting does not lead to maximum survival. It seems that it is best to delay the planting out until the individual spat are about 5 mm. across. Unless the settling season is unusually late it is found that spat planted out in the autumn should be large enough to detach from the tiles by the following May or June. A size of 2 cm. should be reached in ten months. After detachment the spat is placed fairly thickly in shallow wire-covered trays, raised on the bottom. Growth is rapid. These oysters should be ready for planting on firm bottom without protection when twenty months old, the average size of a good sample of brood from the Conway tanks at this age being about 5 cm. Samples of such broods have been sold to the oyster growers and have done well after transplanting.

It is encouraging to realize that the tank breeding process may be put forward as a possible means of replenishing the stocks of home-grown oysters on British beds, and that Mr. Cole is justified in his statement that "the results of these three years (1936, 1937 and 1938) taken together, fully warrant the conclusions that a commercial crop of oyster spat can be obtained annually, with reasonable certainty".

SCIENCE NEWS A CENTURY AGO

The Steamship *President*

THE *Annual Register* for 1839 records that on October 7, "Several thousand persons went to Limehouse to view the immense steamship the *President*, built by Messrs. Curling and Young for the British and American Steam Navigation Co., and intended to run between New York and London. The *President* is of greater power and tonnage than the *British Queen* (the former being of 600 horse power and 2,336 tons, the latter 500 horse power and 2,016 tons), and was built in the same dock, and not upon a slip; so that she had to be floated out of dock, and not launched. At high tide, however, which happened to be a low tide, there was not enough water to float her, and she remained fast aground aft. Mrs. Laird, wife of the African explorer and projector of Atlantic navigation by great steamships, performed the ceremony of christening, amidst the cheers of the multitudes on the banks and on the river. . . . On Monday the 9th, the water being sufficient, the *President* was floated into the river and towed to Blackwall."

The *President* was the largest of the pioneer Atlantic steamships, but her career was a very short one. She left New York on March 11, 1841, on her third homeward voyage, and foundered next day in a gale, all aboard being lost.

Royal Cornwall Polytechnic Society

THE seventh annual meeting of this Society was held on October 8, 1839, in the Polytechnic Hall, Falmouth, Sir C. Lemon, M.P., being in the chair. Several premiums were awarded for mechanical and scientific inventions and improvements. Among the notices in the report was a reference to Prof. Moseley's suggestion for calculating the "Efficiency of Steam Engines", a matter of great interest to all Cornish engineers. His proposal was to use a small cylinder, of about six inches diameter, connected with the large cylinder of the engine, the piston in the small cylinder being acted upon by a spring. Prof. Henry Moseley (1801–72), F.R.S., whose writings on mechanics, etc., were well known, was professor of natural philosophy in King's College, London, and afterwards one of the first of Her Majesty's inspectors of schools, and canon of Bristol. He was the father of H. W. Moseley (1844–91), Linacre professor at Oxford and grandfather of the physicist H. G. J. Moseley (1887–1915), who was killed in Gallipoli during the Great War.

Electro-magnetism as a Motive Power

DR. JACOBI, said the *Athenæum* of October 12, 1839, in a letter to Faraday thus alludes to this subject:

"In the application of electro-magnetism to the movement of machines, the most important obstacle always has been the embarrassment and difficult manipulation of the battery. This obstacle exists no longer. During the past autumn, and at a season already too advanced, I made, as you may perhaps have learned by the gazetter, the first experiments in navigation on the Neva, with a ten-oared shallop furnished with paddle-wheels, which were put into motion by an electromagnetic machine. Although we journeyed during the entire day, and usually with 10 or 12 persons on board, I was not

well satisfied with this first trial, for there were so many faults of construction and want of insulation in the machines and battery, which could not be repaired on the spot, that I was terribly annoyed. All these repairs and important changes being accomplished, the experiments will shortly be commenced. The experience of the past year, combined with the improvements of the battery, give as the result, that to obtain the force of one horse (steam-engine estimation) it will require a battery of 20 square feet of platina distributed in a convenient manner, but *I hope* that from 8 to 10 square feet will produce the effect. If heaven preserves my health, which is a little affected by continual labours, I hope that within a year of this time I shall have equipped an electro-magnetic vessel of from 40 to 50 horse-power."

The author of these experiments, the first made on electric propulsion, was Moritz Herman von Jacobi (1801–1875), who for many years was a professor at St. Petersburg.

Medical School at Athens

THE issue of the *London Medical Gazette* of October 12, 1839, contains the following information: "An attempt is making at Athens, the present capital of the modern Greek Empire, to organize a medical school, by several well-educated and respectable Bavarian physicians and surgeons, who are attached to the Court, and whom King Otho has induced to settle in his country. . . . They had from nine to twelve pupils, natives of the country, who were lectured to by a German in the modern Greek language; the professors, from a residence of several years in the country, being able to impart instruction to their pupils in their native tongue. Although it is the merest beginning of a medical school, it is nevertheless praiseworthy and honourable in its present founders, and may be the germ of an institution which shall move onward hand in hand with the regeneration of poor fallen Greece. . . . Athens possesses at this moment a most excellent military hospital, arranged upon the modern European plan, capable of containing very comfortably several hundred patients. Also a highly respectable and well-arranged cabinet of Natural History."

Subterranean Forest

THE *Gentleman's Magazine* for October 1839 contains the following information: "The capacious bonding pond, which is now being excavated at South Stockton, has led to the discovery of an extensive subterranean forest. The timber is chiefly oak. A yew tree, of considerable size, has been found, the wood of which is sound and good and fit for the turner's lathe. Many of the oaks are of large dimensions, and it is expected that some of them will be suitable for the purpose of building. Whilst examining this forest, Dr. Young of Whitby, with some friends discovered one of the oaks to have been cut in two, which had evidently been done previous to its being covered by the earth. He supposes the forest must have been cut down by the Roman soldiers, as they were in the habit of laying timber on the low swampy grounds for the purpose of making roads. Be this as it may, it is certain the hand of man has been exercised on the timber, and it may form a fertile subject for the lover of ancient history and the geologist to speculate on".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT I (reference B.401) and ASSISTANT II (reference B.402) at Air Ministry Headquarters—The Under Secretary of State, Air Ministry, Department 2A (B/127), Harrogate, Yorks (October 13).

COMMISSIONED ORDNANCE MECHANICAL ENGINEERS in the Indian Army Ordnance Corps—The Secretary, Military Department, India Office, S.W.1 (quoting O.M.E. Recruitment) (October 17).

ASSISTANT ENGINEER for the Drainage and Irrigation Department, Malaya—The Crown Agents for the Colonies, 4 Millbank, S.W.1 quoting M/5765).

METEOROLOGICAL ASSISTANTS (Male) in the Meteorological Office—The Under-Secretary of State, S.2.B.(Met.), Department Q.J., Air Ministry, Adastral House, Kingsway, W.C.2.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Report on the Fish and Fisheries of Lake Rukwa in Tanganyika Territory and the Bangweulu Region in Northern Rhodesia. By C. K. Ricardo. (Published on behalf of the Governments of Tanganyika Territory and Northern Rhodesia.) Pp. 78. (London: Crown Agents for the Colonies.) 6*s*. [159

University of Manchester: Faculty of Technology. Prospectus of University Courses in the Municipal College of Technology, Manchester, Session 1939–40. Pp. 418. (Manchester: Municipal College of Technology.) [159

Proceedings of the Royal Society of Edinburgh, Session 1938–1939. Vol. 59, Part 2, No. 18: Tests of Significance of the Differences between Regression Coefficients derived from Two Sets of Correlated Variates. By Dr. F. Yates. Pp. 184–194. 1*s*. Vol. 59, Part 2, No. 19: On the Reciprocation of Certain Matrices. By A. R. Collar. Pp. 195–206. 1*s*. Vol. 59, Part 2, No. 20: Studies on Reproduction in the Albino Mouse. 3: The Duration of Life of Spermatozoa in the Female Reproductive Tract. By Hugo Merton. Pp. 207–218. 1*s*. Vol. 59, Part 2, No. 21: Reciprocity and the Number 137, Part I. By Prof. Max Born. Pp. 219–223. 6*d*. (Edinburgh: Robert Grant and Son, Ltd.; London: Williams and Norgate, Ltd.) [159

Transactions of the Royal Society of Edinburgh. Vol. 59, Part 3, No. 29: An Early *Dictyoconus*, and the Genus *Orbitolina*; their Contemporaneity, Structural Distinction, and Respective Natural Allies. By Lt.-Col. L. M. Davies. Pp. 773–790+2 plates. (Edinburgh: Robert Grant and Son, Ltd.; London: Williams and Norgate, Ltd.) 3*s*. [159

Other Countries

Proceedings of the United States National Museum. Vol. 86, No. 3065: Neotropical Flies of the Family Stratiomyidæ in the United States National Museum. By Maurice T. James. Pp. 595–608. Vol. 87, No. 3066: Ceratopsian Dinosaurs from the Two Medicine Formation, Upper Cretaceous of Montana. By Charles W. Gilmore. Pp. 18. Vol. 87, No. 3067: Two New Parasitic Isopods from the Eastern Coast of North America. By A. S. Pearse and Henry A. Walker. Pp. 19–24. (Washington, D.C.: Government Printing Office.) [159

Smithsonian Miscellaneous Collections. Vol. 98, No. 20: The Helt Township (Indiana) Meteorite. By Stuart H. Perry. (Publication 3546.) Pp. ii+7+9 plates. (Washington, D.C.: Smithsonian Institution.) [159

Advisory Committee on Education. Staff Study No. 10: The Land-Grant Colleges. By George A. Works and Barton Morgan. Pp. ix+141. 25 cents. Staff Study No. 18: Educational Service for Indians. By Lloyd E. Blauch. Pp. xii+137. 25 cents. Staff Study No. 19: Research in the United States Office of Education. By Charles H. Judd. Pp. viii+133. 20 cents. (Washington, D.C.: Government Printing Office.) [159

U.S. Department of the Interior: Office of Education. Vocational Division Bulletin No. 196 (Agricultural Series No. 52): Farm Forestry; Timber Farming including Woods Management and Forest Tree Planting. By W. A. Ross and W. R. Mattoon. Pp. vi+63. (Washington, D.C.: Government Printing Office.) 15 cents. [159

Transactions of the San Diego Society of Natural History. Vol. 9, No. 10: The Holotype of *Barbatia* (*Acar*) *gradata* (Broderip and Sowerby). By Philip W. Reinhart. Pp. 39–46+plate 3. Vol. 9, No. 11: The Silky Pocket Mice of Southern California and Northern Lower California, Mexico, with the Description of a New Race. By Laurence M. Huey. Pp. 47–54. Vol. 9, No. 12: A New Silky Pocket Mouse from Southwestern Utah. By Laurence M. Huey. Pp. 55–56. Vol. 9, No. 13: A New *Perognathus arenarius* from near the U.S.-Mexican Boundary in Lower California. By Laurence M. Huey. Pp. 57–58. Vol. 9, No. 14: Three New Worm Snakes of the Genus *Leptotyphlops*. By Laurence M. Klauber. Pp. 59–66. (San Diego, Calif.: San Diego Society of Natural History.) [159

Bulletin of the American Museum of Natural History. Vol. 76, Art. 4: On the Anatomy and Evolution of the Locomotor Apparatus of the Nipple-tailed Ocean Sunfish (*Masturus lanceolatus*). By Henry C. Raven. Pp. 143–150. (New York: American Museum of Natural History.) [159